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THE SHIP ACQUISITION PROCESS:
AN INTERORGANIZATIONAL PERSPECTIVE

Hayden Louis Leon

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THESIS

THE SHIP ACQUISITION PROCESS:
AN INTERORGANIZATIONAL PERSPECTIVE

by

Hayden Louis Leon, Jr.

March, 1976

Thesis Advisor: C. R. Jones

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The ship acquisition process consists of the development and production of a ship and its systems by organizations bound into a structure by existing laws, regulations, and practices. One of the major determinants of efficiency and effectiveness of this process is the correlation of the structure with the tasks associated with acquisition of the ship. Real and/or perceived problems are indicated in the proces by adverse publicity and

management actions. The thesis contains a review of organizational theory relating structure, tasks, conduct and performance. The structure and tasks associated with ship acquisition are examined and an example is provided from the Patrol Frigate design showing the relationship of structure and tasks.

The author concludes the ship acquisition structure is not theoretically well matched at a point in time with the tasks it required to perform and a coordinated longitudinal investigation of the weapons acquisition process is needed. A framework for this investigation is suggested.

The Ship Acquisition Process:
An Interorganizational Perspective

by

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Lieutenant Commander, United States Navy
B.S., United States Naval Academy, 1959

Submitted in partial fulfillment of the
requirements for the degree of

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TABLE OF CONTENTS

I. INTRODUCTION------------------------------- 15

A. SCOPE OF THE THESIS--------------------- 15

B. THE PROBLEM------------------------------ 18

C. THE COMMISSION ON GOVERNMENT PROCUREMENT 24

1. Establishing the Needs and Goals---- 26

2. Exploring Alternative Systems------- 27

3. Choosing a Preferred System--------- 31

4. System Implementation--------------- 32

5. The Results------------------------- 34

D. GOVERNMENT ACCOUNTING OFFICE------------ 37

1. Cost Estimating--------------------- 37

2. Greater Capability Demanded--------- 38

3. Acquisition Management-------------- 39

E. SENATOR PROXMIRE------------------------ 42

F. MEASURES OF EFFECTIVENESS--------------- 44

1. Schedule and Performance------------ 46

2. Cost-------------------------------- 47

a. Cost Estimating----------------- 48

b. Cost Growth--------------------- 50

c. Inflation----------------------- 52

3. System and Program Changes---------- 52

II. VIEWS OF ORGANIZATIONS--------------------- 56

A. BUREAUCRACY----------------------------- 56

1. History and Definition of Bureaucracy 56

2. Advantages and Disadvantages of Bureaucracy------------------------- 59

B. STRUCTURE, CONDUCT AND PERFORMANCE RELATIONSHIPS------------------------- 61

1. Relationships---------------------- 61

2. Strengths and Weaknesses of the View 63

3. Results of Changes----------------- 64

C. VIEWS OF ORGANIZATION----------------- 65

1. Bureaucratic Model----------------- 65

2. Open System Model------------------ 66

3. Mixed System Model----------------- 68

4. Quantification of Government Bureaucracy 74

5. The Popular View------------------- 76

D. VARIABLES------------------------------ 77

1. Organizational Variables----------- 78

2. Task Variables--------------------- 80

3. Environmental Variables------------ 81

E. THE APPLIED STRUCTURE, CONDUCT AND PERFORMANCE FRAMEWORK------------------ 82

F. THE APPLIED VIEW OF SHIP'S ACQUISITION STRUCTURE AND TASK--------------------- 85

III. STRUCTURE OF THE NAVY SHIPS WEAPONS SYSTEM ACQUISITION PROCESS------------------------ 90

A. THE WEAPONS SYSTEM ACQUISITION PROCESS-- 90

B. THE PLAYERS---------------------------- 95

1. Department of Defense-------------- 96

a. Office of the Secretary of Defense 97

b. Office of the Secretary of Navy 101

c. Chief of Naval Operations 104

d. Chief of Naval Material 107

e. Commander Naval Sea Systems Command 110

2. The Executive Branch---------------- 112

3. The Legislative Branch--------------- 115

a. Congressional Committees-------- 115

b. Congressional Budget Office----- 116

c. General Accounting Office------- 117

4. The Judicial Branch----------------- 117

5. Contractors-------------------------- 118

6. Other Groups Influencing the Ships Acquisiton Process------------------ 121

a. Financial Institutions---------- 121

b. Labor Related Factors----------- 121

c. Material Related Factors-------- 125

d. State and Local Government------ 125

e. Citizens Groups----------------- 126

f. Professional, Trade and Industrial Organizations-------------------- 126

C. COORDINATING AND DIRECTING MECHANISMS--- 127

1. Acts of Congress-------------------- 127

a. Funding and Authorization Acts-- 127

b. Governing Acts------------------ 128

2. Decisions--------------------------- 129

a. Comptroller General------------- 129

b. Attorney General---------------- 129

c. Armed Services Board of Contract Appeals------------------------ 131

d. The Courts---------------------- 131

3. Presidential Directives------------- 131

4. Department of Defense Directives---- 132

5. Planning, Programming and Budgeting System Related Documents------------ 132

6. System Approval Related Documents--- 132

7. Selected Acquisition Reports-------- 133

8. General Accounting Office Reports--- 133

9. Contracts--------------------------- 133

10. Armed Services Procurement Regulations 134

D. DEFENSE SYSTEM ACQUISITION REVIEW PROCESS 135

E. DEMAND------------------------------- 137

1. Perception of Need------------------ 138

2. Political Environment--------------- 139

3. Production-------------------------- 140

F. FINANCING---------------------------- 140

1. The Budget Process------------------ 142

2. Methods of Financing the Contractor 144

IV. TASKS REQUIRED IN SHIP ACQUISITION---------- 146

A. SHIP ACQUISITION TASKS------------------ 146

B. SYSTEMS ORIENTED TASKS------------------ 149

1. Tasks Associated with Individual Systems----------------------------- 149

2. Integrated System/Ship Tasks-------- 151

C. CROSS SYSTEM TASKS---------------------- 153

1. Configuration Management------------ 153

2. Test and Evaluation----------------- 154

3. Manning----------------------------- 156

4. Reliability, Maintainability, and Availability------------------------- 156

5. Supply Support---------------------- 157

6. Maintenance Support----------------- 158

7. Scheduling---------------------------- 159

8. Operational Software Provision------ 160

D. FINANCES------------------------------------ 160

1. Budgeting Task---------------------- 160

2. Appropriation Task------------------ 161

3. Allocation Task--------------------- 161

4. Contracting/Obligation Task--------- 162

5. Payment (Expenditure) Task---------- 162

6. Readjustment Task------------------- 162

7. Financial Management Task----------- 163

E. PROGRAM CONTROL AND MONITORING---------- 163

1. Expenditure Monitoring and Control-- 164

2. Program Progress and Control-------- 165

F. SYSTEMS------------------------------------ 166

V. TASK ACCOMPLISHMENT UNDER THE EXISITING SYSTEM 168

A. THE PATROL FRIGATE---------------------- 168

1. Personnel Turnover------------------ 175

2. Ship Service Diesel Generators------ 177

3. Major Changes----------------------- 181

4. DSARC III Briefings----------------- 184

B. INTERFACE PROBLEMS---------------------- 186

VI. CONCLUSIONS AND RECOMMENDATIONS------------- 189

A. CORRELATION OF STRUCTURE AND TASK------- 189

1. Patrol Frigate Diesel Generator Example 189

2. Ship Acquisition Structure---------- 192

3. Ship Acquisition Tasks-------------- 193

4. Comparison of Ship Acquisition Structure and Task----------------- 193

B. RECOMMENDATIONS------------------------- 194

1. Staff Units and Overhead------------ 194

2. Management Continuity--------------- 195

3. Task Division----------------------- 197

4. Further Research-------------------- 198

APPENDIX A: Recommendations on Acquisition of Major Systems - by Commission on Government Procurement December 1972------------ 203

APPENDIX B: Directives Applicable to the Acquisition of a Naval Ship---------------------- 209

APPENDIX C: Documents Relating to the Planning, Programming and Budgeting Office----- 212

APPENDIX D: Documents Relating to System Approval 219

APPENDIX E: General Accounting Office Reports Applicable to Navy Weapons System Acquisition-------------------------- 224

LIST OF REFERENCES---------------------------- 227

INITIAL DISTRIBUTION LIST--------------------- 235

LIST OF TABLES

I. Major Private U.S. Shipyards---------------- 119

II. Major Ship System Contractors--------------- 122

III. Major Statutes Relating to Weapons System Acquisition----------------------------------- 130

IV. Two Months of Patrol Frigate Project Manager Formal Interfaces---------------------------- 173

V. Major Priced Changes to the Patrol Frigate-- 182

LIST OF FIGURES

1. Current Patterns of Establishing Needs and Goals for New Acquisition Efforts------------ 28

2. Present Basic Pattern of System Evolution----- 30

3. Major System Acquisition-Recommended Action--- 36

4. Technology Variables-------------------------- 71

5. Relationship of Task to Structural Characteristics 72

6. Organization Models--------------------------- 84

7. Structure of Ship's Acquisition--------------- 86

8. Tasks of Ship's Acquisition------------------- 88

9. Idealized Program Phases---------------------- 93

10. Integrated Procurement Process---------------- 94

11. Organization of the Secretary of Defense----- 98

12. Organization of the Secretary of Navy and Chief of Naval Operations--------------------------- 103

13. Navy Systems Acquisition---------------------- 105

14. Organization of the Chief of Naval Material--- 109

15. Organization of Commander - Naval Sea System Command-- 111

16. Interrelationship of Factors Involved in the Acquisition of New Weapons Systems------------ 141

17. Ship Acquisition Interaction Incidence Mattrix- 199

18. Inputs and Outputs to Organization------------ 201

FORWARD

There is no generally accepted framework for consideration of the interaction of organizations. Part of the purpose of this study is to explore the potential methods for approching such a study. The shear magnitude of the relationships possible within the weapons system acquisition process incredibly complicates such a study. If only the five major players in the ship acquisition structure are considered, there are 10 relationships between pairs of organizations that are possible. If the 18 significant players which will be identified in the thesis are considered, 153 relationships between pairs of organizations are possible. A general framework for consideration of such a large structure is presently beyond the standard works in organizational analysis.

This thesis is being directed at two levels of readership, those with a significant knowledge of the weapons acquisition process and those with only a basic understanding of the process. For those already knowledgable, this thesis will provide a checklist of building blocks and a framework for consideration of the structure as a whole. For those having only a basic knowledge, the thesis will additionally provide a broad overview of the structure, tasks, conduct and performance of the ship acquisition process. The reader who is familiar with contemporary and historical

organizational theory may wish to omit reading Chapter II. The reader familiar with the details of the Weapons System Acquisition Process may wish to omit Chapter III and those familiar with naval ship construction may wish to omit Chapter IV.

Finally, background descriptions of existing organization doctrine, of the structure of the ship acquisition process and of tasks associated with ship acquisition are being provided without value judgements. It is the author's intention to provide, in terms of existing organizational theory, a framework with which the existing methods of ship development and construction and present ship acquisition structure can be considered. With these tools, the author feels that the entire structure can be evaluated once priorities for the goals and outputs of the system are clearly defined.

I. INTRODUCTION

A. SCOPE OF THE THESIS

The ship acquisition process consists of the development and production of a ship. The process starts from the recognition of need for a ship, proceeds through the design of the ship, including integration of the individual ship systems, and continues through the production and deployment of the ship. Associated with this is the development and production of individual system that will be incorporated in the ship. This process is accomplished by large organizations within the government and private industry that are bound into a structure by existing laws, regulations and practices.

The news media and various individuals and groups within the government have reported significant real and/or perceived problems with the ship acquisition process. These problems generally relate to difficulties experienced in meeting the original goals of cost, schedule and performance in the development and construction of the ship and to changes made during this period. In the following sections of this chapter, the views of three major weapons system acquisition critics will be reviewed. Problems inherent in the use of cost, schedule, performance and specification or mission changes as measures of effectiveness will also be discussed. The author concludes that these measures are valid, though subject to measurement error, if the final product of the

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process is the ship. Other goals of the process, such as the support of social programs, and the ability to actually fight a battle, are difficult to quantify and/or observe, but should be considered by a decision maker evaluating the process.

The major organizations involved in the ship acquisition process are large bureaucracies, exhibiting the characteristics of traditional bureaucracies. The full range of organizations contributing to the process exhibit or should exibit characteristics of organizations varying from almost classic bureaucracies to open organizations. This is based on the premise that the structure of organizations determines their conduct. When the structure and conduct of the organizations are compared with the tasks required to be done by the organizations, performance can be predicted. In other words, the structure should be appropriate for the task required of it. The theoretical background for this view will be discussed.

Provided the value of the correlation of the structure and tasks of an organization, the structure and tasks of the ship acquisition process will be examined. The structure of the ship acquisition processes is made up of the organizations of the Department of Defense, the Executive Branch (for this thesis, exclusive of the Department of Defense), the Legislative Branch, the Judicial Branch and Contractors, coordinating and directing mechanisms, the defense system acquisition review process, the demand for systems and the means of financing the ship. Each of the major elements of

the structure is made up of subelements that further complicate the relationships. To provide a basis for comparison, the thesis describes the organizations and the connecting factors that the author feels are relevant to the ship acquisition process. The tasks associated with the acquisition of a ship are then described in order to contrast them with the structure.

An example of the relationship of structure and task from the design of the Patrol Frigate (FFG-7) is provided. The use of the Patrol Frigate project for research was largely dictated by availability, but the example demonstrates the effect of apparent mismatch between that portion of the structure applicable to the case in question and the tasks to be accomplished. The resultant changes to the ship were very costly to the Navy.

The author concludes that the ship acquisition structure is not theoretically well matched with the tasks required of it at any specific point of time. The changes in the characteristics of the tasks over the period of the ship acquisition are not matched by a commensurate change in the structure. The decision maker must, of course, weigh the costs of the resulting performance against the costs of changing the structure to arrive at a "best" solution. He must also consider the other goals of the elements of the structure.

The recommendations resultant from this study are:

1. That some measure of output of staff groups within the

ship acquisition structure be implemented. Allocation of operating funds to staff groups through Project Offices in a manner similar to industrial funding is a potential means for initiating this form of evaluation.

2. That an attempt be made to better match the timing of the change of key personnel associated with a ship acquisition project to the major changes in the tasks associated with the development of the individual systems and with the development and construction of the ship itself.

3. That the development of the individual systems through proof of the basic concept be separated from the development and construction of the ship.

4. That a coordinated study of all facets of ship acquisition be conducted. This study should be consider the means by which each organization in the process transforms inputs to outputs, the relationship of the organizations to each other and to the structure as a whole and the effects of changing one part of the structure on the other parts of the structure. Each phase of this study should consider the entire acquisition process, including the effects of the earlier phases of the process on the later phases and the resulting output.

B. THE PROBLEM

Each year Congress, in effect, decides how the limited resources of the United States shall be divided between the private sector and the national government of the economy by the passage of appropriation legislation. They further decide how that portion of the resourses allocated to the national government shall be divided between national defense and other competing needs for public goods and services. Finally, they specify, within the funds appropriated for national defense, how much shall go to each major defense sector. Within these sectors it is broken into subsector and alloted by service. Examples of subsectors are: Procurement, Missile, Army; Procurement, Vessels, Navy and

Research, Development, Test and Evaluation, Air Force. The subsectors are further broken into items called Programs, such as Patrol Frigate and Nuclear Attack Submarine - both under Procurement, Vessels, Navy.

Since 1960, the defense budget has consumed less than 50% of the national budget and has shown a generally decreasing trend. As a percentage of Gross National Product, the defense budget has also shown a decreasing trend. Although the amount of current year dollars appropriated to the budget has continued to increase, inflation has kept the level of funding in fixed year dollars relatively constant. (35:pp. 26-31.)

Navy shipbuilding, conversion and repair funds have, however, stayed relatively stable in relation to general inflation when measured by the Gross National Product (GNP) deflater. They have also remained a reasonably constant percentage of Gross National Product itself.(26)(27) The same may be said for Navy Research and Development. This stable fixed year dollar budget has been overtaken by an even faster rise in shipbuilding costs. While the GNP deflater rose an average of 8.3% per year between 1970 and 1975, shipbuilding costs have been increasing from 15 to 22% annually.(49:p. 69) Additionally, ships are becoming more sophisticated, raising the procurement costs of each succeeding generation of ships, even when measured in fixed year dollars. Based on a sample of defense systems and on the assumption that procurement funds will be available at

current levels, the Commission on Government Procurement estimated that there is a shortage of about five billion dollars in procurement funds needed in 1972 to maintain planned force levels for their selected sample. $190 million of this was required for Navy shipbuilding.(19:p. 107.) Thus, the Navy department is faced with the dilemma of rising costs in the face of limited resources. In the author's view, six solutions to this dilemma are possible. The Department of Defense can:

- Reallocate resources between programs and sometimes obtain reprogramming authority from Congress
- Obtain higher than planned appropriations from Congress in succeeding years
- Reduce the number of units to be procured and deployed (force levels)
- Reduce the rate at which units are procured and deployed while reducing the rate at which units are retired from the active forces
- Reduce the operational capability of the individual units in order to increase the quantity procured.
- Improve the efficiency of the weapon system acquisition process.

Although the shifting of funds between programs that accomplish the same mission could theoretically put the money to more efficient or effective use, discussions with senior weapons procurement officials indicate that actual shifting is usually done based on the desire to keep the program operating at the same rate instead of efficiency or effectiveness of use. Even if increased efficiency or effectiveness of funds usage was the goal of shifting, the difference in missions between programs would make comparison

of cost effectiveness difficult if not impossible in most cases.

Obtaining higher funding from Congress in succeeding years is often included in long range planning. A review of successive Department of the Nave Five Year Defense Plans shows that Congress seldom provides the additional funds to make up the short falls of previous years. As a result, dependence on this method of solution has proved less than satisfactory.

Reduction in the quantity and rate of procurement is the principle method of reducing procurement cost practiced by Department of Defense. The reduction in the rate of procurement results in more time for inflation to act on the later items in the procurement. As an example, the estimated unit price of an SSN 688 Class submarine went from $203 million to $229 million when its procurement was slipped two years.(31) This represents a 6.2% total price change. Most of this change can be considered as coming from inflation based on the Selected Acquisition Report presentation. If the inflation of 15-22% cited by Admiral Kidd remains in effect, the cost would rise to between $268 million and $302 million. Learning curve benefits would also be lost by reducing the production rate in relation to personnel turnover. Reduction in force levels, on the other hand, has "caused increasing concern."(19:p. 107) As an example, the Commission on Government Procurement quotes the Chairman of the Senate Armed Services Committee as saying:

> "At these stratospheric price levels, there has been a tendency in the Pentagon to cut back on costly weapon orders ... when costs under a given contract begin to escalate. Our committee has suggested that this sort of backing and filling would leave us with forces inadequate to perform their assigned missions."(19:p. 107)

The Department of Defense is currently attempting to design some new systems to a unit cost in an attempt to reverse the trend of decreasing force levels and increasing unit costs.(19:p. 107) The cost of the Patrol Frigate, designed under this concept has increased only 18.6% over the development estimate, net of escalation. If the unit cost is examined including escalation, however, the cost has risen 86.6%.

The final solution is the increase in efficiency of the weapons acquisition process. Thousands of pages of testimony, several books and many studies have been devoted to this subject. Opinions vary widely on who or what is the culpret and what the appropriate "fix" is to the problem. Most observers have concentrated on segments of the weapons acquisition process without considering the process as a whole.(19:p. 1) Their recommendations thus dealt with only a small portion of the process. In the author's view, those who claim to take an integrated view of the acquisition process did not look at the structure as a whole, including all of the relationships of the various parts of the structure. This does not imply that some solution or combination of these solutions derived from these studies would not improve the process. The opinion of the author is only that if the effect of a change to one part of the

structure in relation to its effects on other parts of the structure is not considered, there is a significant chance that unforeseen results will ensue. The resistance of the structure to change is also generally not considered.

The gravity of the situation was described by Senator Chiles in his opening statement to the hearing on Major Systems Acquisition Reform in June 1975:

> "I think it's worth spending a minute to step back and look at what we are talking about when we hear the words "major systems acquisition."
>
> "To most people, the words mean C-5's; F-111's; and other weapons like the F-16 and F-18 air combat fighters we used as a case example in earlier hearings....
>
> "To most people, major systems also means a heck of a lot of money: $80 million for a B-1 bomber: $1 billion for a Trident submarine or a nuclear carrier: $8 billion for a space shuttle program: $150 billion worth of weapons systems underway, according to Defense Department accounts: $1 trillion worth, according to one witness....
>
> "Then, again, to most people, major systems means waste; cost overruns; missiles exploding; planes crashing; programs canceled; engines falling apart; loose wheels rolling down the runway; contractor buy-ins and contractor bailouts....
>
> "Our weapons acquisitions programs - no matter how good they might look to the military; no matter how bad they might look to the critics -- they have not looked good enough to either enjoy or deserve the confidence of the American taxpayers who are footing the bill.
>
> "We are simply not getting every dollar's worth of defense that we know we could be getting out of our technology, our industry, our defense establishment."(89:pp.1-2)

Headlines like "U.S. Failing to Hold Down Arms Costs" (Los Angeles Times, August 23, 1975), "Defense Dollar Ripoffs Assailed" (Monterey Peninsula Hearld, November 28, 1975) and "Pentagon Says Cost for 50 New Frigates is Up $1.88 Billion" (The Wall Street Journal, November 20, 1975)

reflect this concern. A sampling taken from the June 1975 Selected Acquisiton Reports of 11 major ship and shipborne weapon systems showed an average growth in unit cost from development estimate to current estimate of 54.9% for ships and 41.9% for weapons. This does not present the entire picture, though, as ships cost growth varied from 25.9% to 119.8% and weapons varied from 13.6% to 58.1%. With cost growth of this magnitude and so much bad publicity, improvement would appear to be necessary.

Three of the major views of the weapons acquisition process are provided by the Commission on Government Procurement, the Government Accounting Office and Senator Proxmire. These views are presented in the following paragraphs.

C. THE COMMISSION ON GOVERNMENT PROCUREMENT

Created by Public Law 91-129 in November 1969, the Commission on Government Procurement was charged to:

> "study and investigate the present statutes affecting Government procurement; the procurement policies, rules, regulations, procedures, and practices followed by the departments, bureaus, agencies, boards, commissions, offices, independent establishments, and instrumentalities of the executive branch of the Federal Government; and the organizations by which procurement is accomplished to determine to what extent these facilitate the policy...
>
> "... of Congress to promote economy, efficiency, and effectiveness in the procurement of goods, services and facilities by and for the executive branch of the Federal Government by-
>
> (1) establishing policies, procedures, and practices which will require the Government to acquire goods, services, and facilities of the requisite quality and within the time needed at the lowest reasonable cost, utilizing competitive bidding to the maximum extent practicable;

> (2) improving the quality, efficiency, economy, and performance of Government procurement organizations and personnel;
> (3) avoiding or eliminating unnecessary overlapping or duplication of procurement and related activities;
> (4) avoiding or eliminating unnecessary or redundant requirements placed on contractor and Federal procurement officials;
> (5) identifying gaps, omissions, or inconsistencies in procurement laws, regulations, and directives and in other laws, regulations, and directives, relating to or affecting procurement;
> (6) achieving greater uniformity and simplicity whenever appropriate, in procurement procedures;
> (7) coordinating procurement policies and programs of the several departments and agencies;
> (8) conforming procurement policies and programs, whenever appropriate, to other established Government policies and programs;
> (9) Minimizing possible disruptive effects of Government procurement on particular industries, areas, or occupations;
> (10) improving understanding of Government procurement laws and policies within the Government and by organizations and individuals doing business with the Government;
> (11) promoting fair dealing and equitable relationships among the parties in Government contracting; and
> (12) otherwise promoting economy, efficiency, and effectiveness in Government procurement organizations and operations."(20)

The study approach was built on three points:

> "The system acquisition process draws on the base of technology to create systems to meet national needs.
>
> "The process includes a set of basic steps that must be taken by any agency in any acquistion program.
>
> "Different public and private sector institutions are called on to play roles in order to execute each of the basic steps."(19:p. 28)

The study defined the four basic steps that must be taken in any acquisition program as: Establishing the needs and goals, exploring alternative systems, choosing a preferred system and implementing the system. Implementation of the system included final development, production and deployment

and operation. The study then considered the individual role of each of the principle institutions of the major system acquisition structure in carrying out each of the steps.(19:p. 28)

1. Establishing the Needs and Goals

Three principal problems were perceived by the Commission in the way needs and goals for major systems acquisition programs were established:

- The statement of need did not clearly separate the problem from the solution.
- Needs were defined by each military service with little or no formal agencywide coordination.
- Congress did not have oversight into the need for new acquisition programs.

The Commission Concluded that:

> "The responsibility for identifying and defining defense mission needs that require major system acquisition programs has been delegated to each military service. This contributes to some unplanned duplication of new systems from different services to meet similar needs.
>
> "The first decisions on needs and goals for new acquisition programs significantly affect the kind of system eventually procured. Current statements of needs and goals focus on a preferred system product and not on its purpose. This contributes to rising unit costs and the multimission character of new systems.
>
> "Balancing of program cost, capability and schedule goals is difficult because they are largely predetermined by the "need" for a particular kind of system.
>
> "OSD and the military services do not have consistent hierarchies of defense mission needs. This makes it difficult to coordinate the allocation of resources, mission responsibilities of agency components and needs and goals for new system acquisition programs.
>
> "Roles and mission overlap causes competition among the military services that directly affect the statements of needs for new programs and the size, cost and character of new major weapon systems and permits unplanned overlap in systems and their capabilities.

> "Current budgeting and funding procedures do not facilitate congressional debate on policy, priorities for different kinds of agency mission capabilities or the related needs and goals for new acquisition programs." (19:pp. 52-53)

The Commission's view of the existing pattern of establishing needs and goals for new acquisition efforts is shown in Figure 1.(19:p 41) They recommended that new system acquisition programs be started with agency head statements of needs and goals that have been reconciled with overall agency capabilities and resources. The program needs and goals should be stated independently from any system product, using long-term, coordinated projections of mission capabilitie and deficiencies. The responsibility for responding to needs would be assigned in such a way that either one agency would be responsible or competition between agencies would be formally recognized.

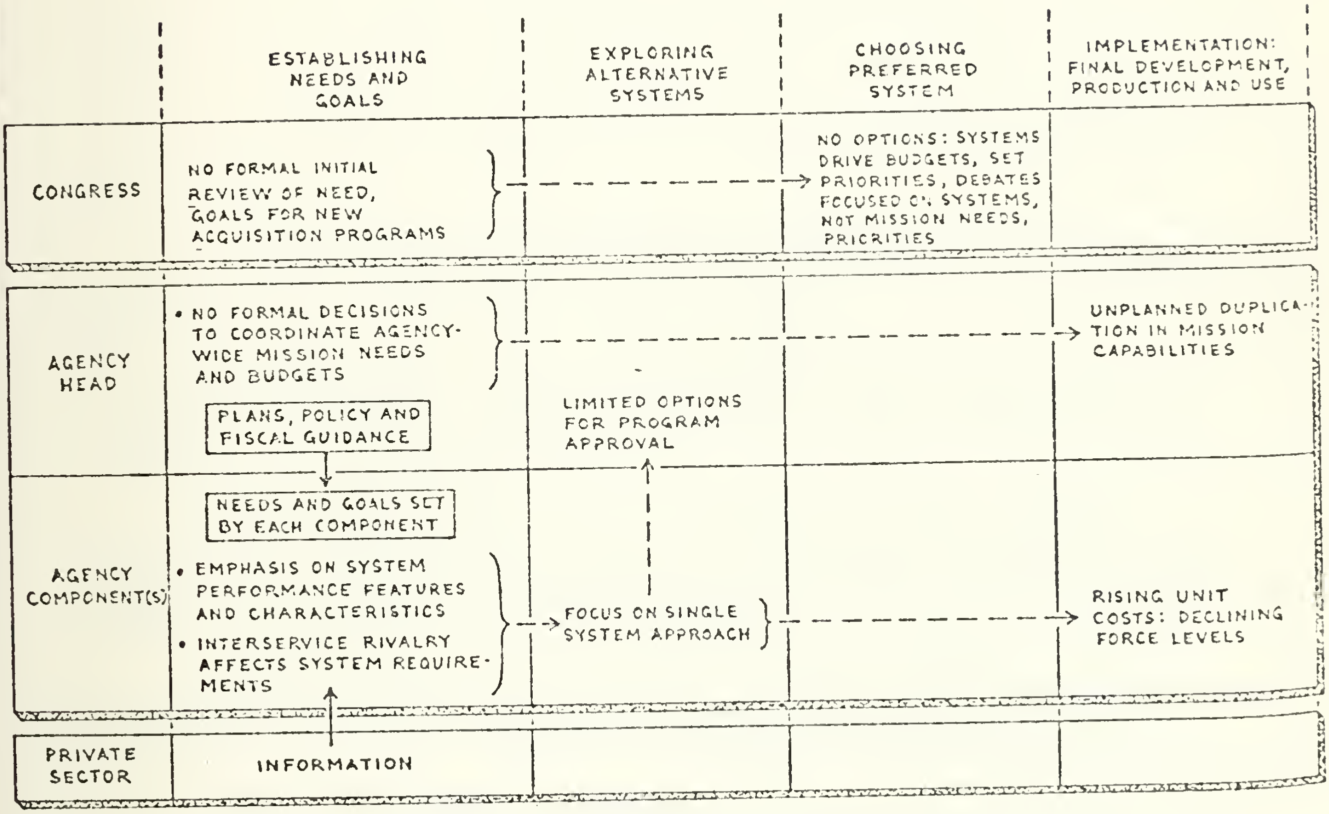
The Commission further recommended that congressional budget proceedings begin with an annual review by the appropriate committees of agency missions, capabilities, deficiencies and the needs and goals for new acquisition programs as a basis for reviewing agency budgets.(19:pp. 53-54) The full text of the recommendations of the Commission on Government Procurement is given in Appendix A.

2. Exploring Alternative Systems

The Commission felt that the technology base was inadequately developed to serve new acquisition programs and the search for candidate systems. The formulation of alternative systems in their view, suffered from premature

CURRENT PATTERN OF ESTABLISHING NEEDS AND GOALS FOR NEW ACQUISITION EFFORTS

PROBLEMS AND IMPLICATIONS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IMPLEMENTATION: FINAL DEVELOPMENT, PRODUCTION AND USE
CONGRESS
NO FORMAL INITIAL REVIEW OF NEED, GOALS FOR NEW ACQUISITION PROGRAMS
NO OPTIONS: SYSTEMS DRIVE BUDGETS, SET PRIORITIES, DEBATES FOCUSED ON SYSTEMS, NOT MISSION NEEDS, PRIORITIES
AGENCY HEAD
• NO FORMAL DECISIONS TO COORDINATE AGENCY-WIDE MISSION NEEDS AND BUDGETS
UNPLANNED DUPLICATION IN MISSION CAPABILITIES
PLANS, POLICY AND FISCAL GUIDANCE
LIMITED OPTIONS FOR PROGRAM APPROVAL
AGENCY COMPONENT(S)
NEEDS AND GOALS SET BY EACH COMPONENT
• EMPHASIS ON SYSTEM PERFORMANCE FEATURES AND CHARACTERISTICS
• INTERSERVICE RIVALRY AFFECTS SYSTEM REQUIREMENTS
FOCUS ON SINGLE SYSTEM APPROACH
RISING UNIT COSTS: DECLINING FORCE LEVELS
PRIVATE SECTOR
INFORMATION

Source: Commission Studies Program.

Figure 1

commitment to system concepts and preliminary designs because of a predetermined design linked to a statement of "need" and the motivational pressures of agency components responsible for creating new systems. Competition in system acquistion was deemed ineffective because the government required contractors to compete to develop and produce a "required" system, not offering their best, low cost solution and Congress and the agencies are placed at cross-purposes by the procedures for financing system exploration.(19:pp. 58-19) Figure 2 is an illustration of the existing basic pattern of exploring alternative systems as observed by the Commission. (19:p. 64)

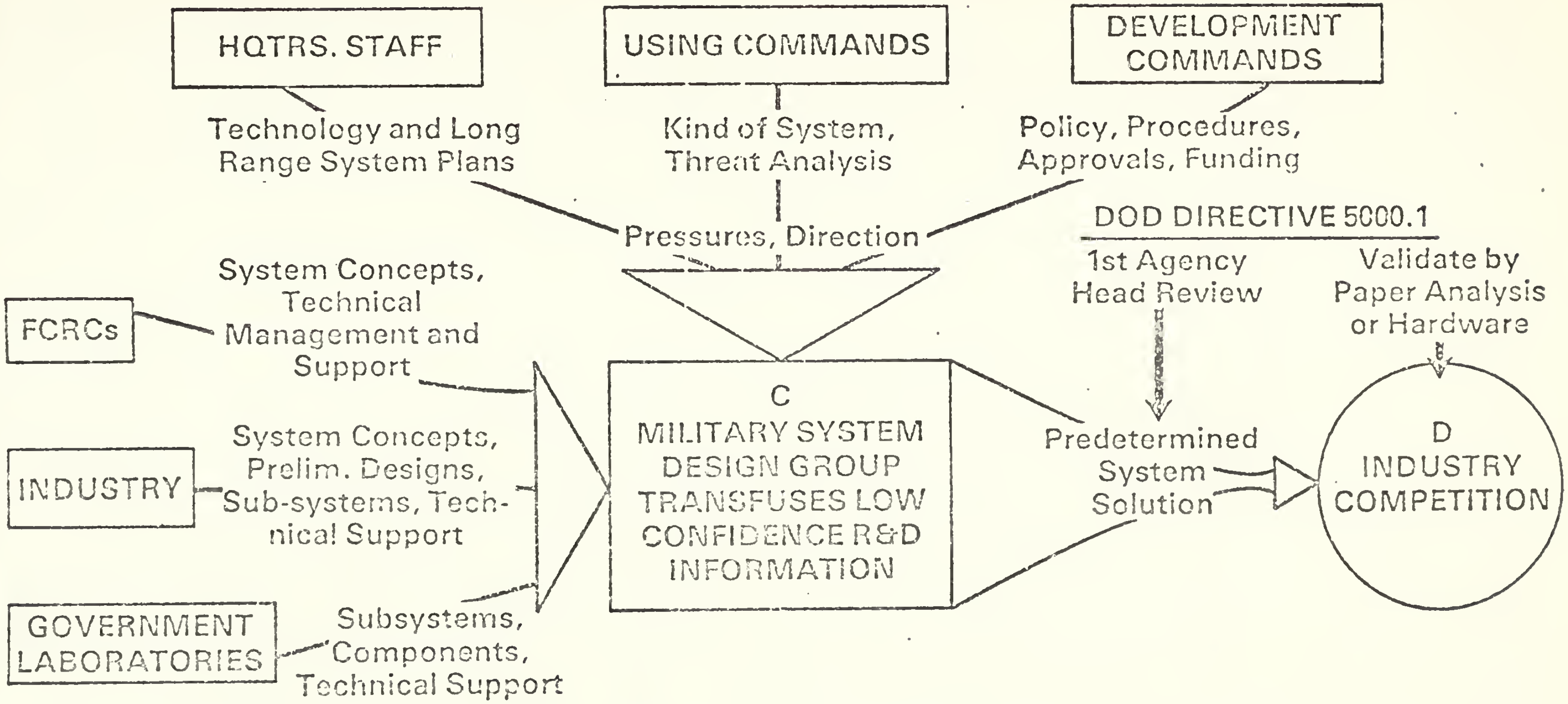
The Commission felt that the practices of creating and developing alternative systems need:

> "Alternative technical approaches, to hedge against changes in mission need and the inability to predict the outcome of technical activity
>
> "A minimum of technical constraints when seeking solution. Selection of early system ideas should be based on the exercise of judgment using agency mission goals and operating constraints as a standard.
>
> "Flexibility to discontinue, modify funding support, or accept new alternative system candidates as the need arises.
>
> "Explicit competition between alternative systems to motivate competing design teams to seek low-cost but adequate solutions.
>
> "Concentration on solving elemental problems of a system before committing to final system development.
>
> "An initial, limited contractual commitment between the Government and each competing contractor, sequentially increasing Government committment as evidence of solutions is developed.

A

PRESENT BASIC PATTERN OF SYSTEMS EVOLUTION

B


HQTRS. STAFF
USING COMMANDS
DEVELOPMENT COMMANDS
Technology and Long Range System Plans
Kind of System, Threat Analysis
Policy, Procedures, Approvals, Funding
Pressures, Direction
DOD DIRECTIVE 5000.1
1st Agency Head Review
Validate by Paper Analysis or Hardware
FCRCs
System Concepts, Technical Management and Support
INDUSTRY
System Concepts, Prelim. Designs, Sub-systems, Technical Support
GOVERNMENT LABORATORIES
Subsystems, Components, Technical Support
C
MILITARY SYSTEM DESIGN GROUP TRANSFUSES LOW CONFIDENCE R&D INFORMATION
Predetermined System Solution
D
INDUSTRY COMPETITION

(A) Situation at Beginning: Needs and Goals Independent of System Solution Not Established/Approved: Pressures Exist to Commit Prematurely to Single System Approach; Mission Responsibilities Unclear.

(B) Unvalidated Design Inputs, Old Technology Stretched, Subsystems Drive Systems, Systems Seek Needs.

(C) Unchallenged Technical Decisions; Operational Concept, Technologies to be Used, Preliminary Design, Performance Requirements; These preset 80-90 Precent of Ultimate Program Cost.

(D) Competes to Develop a "Required" System, Limited Technical Latitude, Promises What Customer Wants, Buy-Ins, no Design Continuity But Accepts Total System Performance Responsibility.

Figure 2

> "Maintenance of worthwile competing designs up to selection for final development; a recognition and understanding that only the best alternative will enter production."(19:p. 85)

These needs were addressed in Recommendations 3 through 6, as shown in Appendix A.

3. Choosing a Preferred System

The major problem in choosing a system, in the view of the Commission, was that financial and other pressures encouraged commitment to a specific system concept too early. The range of technological choice and innovation is narrowed while available research and development information is low-confidence in nature. They felt that an early choice was successful only when "the agency retained total system responsibility and gave itself options for changes, cost-type contracts were used for high risk portions of the program and the best talents in industry and Government could be brought to bear on major technical problems."(19:p. 95)

In order to gain accountability, the Government had initiated multiple staff reviews, regulations and decision layering -- practices that the Commission felt produced "nonproductive costs" that were necessary to an extent, but were not seen or accounted for and "did not measurably improve the system product." Transfusion of desired technical features was seen as narrowing the differences between contractors to the point where selection processes depended on proposed prices at a time of great technical uncertainty. This practice, in turn, created an environment condusive to buy-ins and contentious award with resultant changes and claims. (19:p. 96)

Recommendations 7 and 8 were designed to limit premature system commitments and retain the benefit of system-level competition. The Commission would retain the advantages of agency head decision based on competitive demonstration of candidate systems. Agency head approval would be needed if an agency component determines that it should develop a single system without exploration of alternate candidates. The recommendations and related actions are provided in Appendix A.

4. System Implementation

The Commission found that "the effectiveness of the implementation phase depends on how well the earlier acquisition phases were accomplished. When the earlier phases are not conducted well or are not done, a tremendous burden is placed on functions carried out in the implementation phase."(19:p. 99) 80-90% of the ultimate program costs are preset in the stages before engineering design begins.(89:p. 31)

In their study, the Commission observed that about 15 percent of the cost growth in major programs during the 1960's could be attributed to imprecise cost estimates. The major reasons for avoidable cost growth were: System advocacy and premature commitment, misuse of price competition, overlapping development with production, demands for unachievable performance, demands for increased performance within present technology and sole-source development. The other major problem areas noted in this phase were the

inadequacy of test and evaluation, inadequacies in contracting and problems in the management of programs.

Some increase from the initial estimate was felt to be certain to occur due to human fallibility in estimating, imperfect information and the optimism of Government and industry program advocates. It was further noted that the longer the time period covered by an estimate, the more likely the estimate will be unrealistic. They further found that "decisions to propose a major system program for congressional approval have often been made before high-risk system features have been resolved and before realistic cost estimates can be made, leading to cost growth." This results in systems entering final development and production at costs so much higher than planned that force levels are being substantially reduced.(19:p. 111) Based on these findings, the Committee recommended strengthening the agency's cost estimating capability and withholding selection of a candidate system until alternatives are adequately explored and uncertainties have been narrowed acceptably.

In relation to contracting, it was found that:

> "When system acquisition uncertainties are reduced to an acceptable level in early development, the use of priced production options in contracting for final development may be advantageous and should be permitted.
>
> "Special contract clauses involving limits of Government obligation, contractor total system responsibility, and contract changes represent efforts to fix problems rooted in early acquisition phases. Such clauses do not correct these problems; rather they increase the complexities of contracting and administration and some tend to generate contract claims and disputes.

> "Procurement regulations have developed into voluminous detailed documents that do not accomodate the flexibility and experienced judgment needed to accomplish major system program objectives."

Recommendations were made to allow the use of contracting as a tool of systems acquisition instead of substituting it for management of the program. The specific recommendations are found in Recommendation 10 in Appendix A.

The problems of management included:

- Lack of focus of authority and responsibility for policymaking and monitering of programs and the results of specific policies
- Management layering, overstaffing and redundant reviews and coordinations
- Inconsistancies between policies governing the structure of new system acquisition programs and those governing the procurement tools and contracting tech techniques
- Assignment of program managers after essential performance and cost characteristics have been set.

These problems lead the Commission to recommend the unification of policymaking and monitoring responsibilities for major system acquisitions within each agency and agency component and the delegation of authority for all technical and program decisions to the operating agency components except for the decisions defining mission needs and goals, approving systems for fabrication and demonstration, approving full production release. These are Recommendations 11 and 12 in Appendix A.

5. The Results

In June 1975, E. Perkins McGuire, Former Chairman of the Commission on Government Procurement summed the

recommendations of the Commission with:

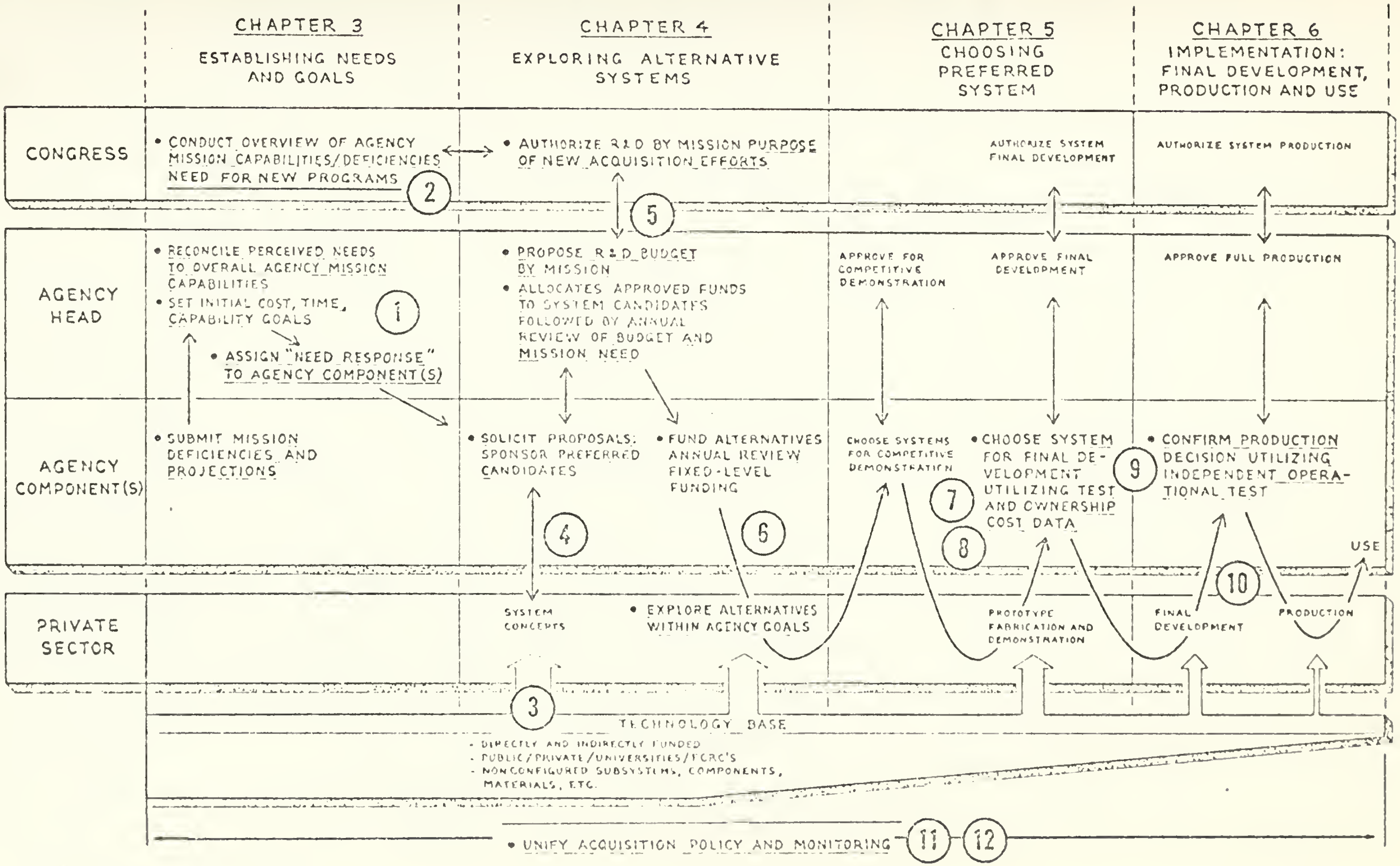
> "These recommendations would facilitate the acquisition of major systems by: Highlighting the key decisions for all involved organizations -- Congress, agency heads, agency components, and the private sector, defining the role of each participating organization, and giving increased visibility to Congress and agency heads by providing the information needed to make key program decisions.
>
> "These recommendations stress the need of a clear understanding of the mission for which funds will be needed and a determination of who will be responsible to carry out that mission.
>
> "They stress the orderly development of a system, once its need is established, utilizing to the maximum extent available know-how, both in Government and industry, with particular attention to the so-called front-end decisions being made only when adequate data are available to make them. I believe that these recommendations will foster more meaningful competition and increased innovations that will give us better and less costly hardware."(89:p. 20)

He further noted that though the executive branch supported the thrust of the recommendations, they had not come to agreement on how to implement them in the time that they had held the report -- over 2 years.(89:p. 20) Mr. Robert R. Judson, former Deputy Director of Commission Studies, Commission on Government Procurement, had the same feeling, saying "I would have to see clear evidence of management reform before I would concede that DOD had made any significant movement, whether they embrace the principles of the recommendations or not."(89;p. 40)

In this author's view, the first question that is apparent is "Why weren't the recommendations implemented?" They seem logical enough and would appear to provide the best utilization of the limited resources available. Looking a

Figure 3 - MAJOR SYSTEM ACQUISITION

• RECOMMENDED ACTIONS


CHAPTER 3
ESTABLISHING NEEDS AND GOALS
CHAPTER 4
EXPLORING ALTERNATIVE SYSTEMS
CHAPTER 5
CHOOSING PREFERRED SYSTEM
CHAPTER 6
IMPLEMENTATION: FINAL DEVELOPMENT, PRODUCTION AND USE
CONGRESS
AGENCY HEAD
AGENCY COMPONENT(S)
PRIVATE SECTOR
• CONDUCT OVERVIEW OF AGENCY MISSION CAPABILITIES/DEFICIENCIES NEED FOR NEW PROGRAMS
• AUTHORIZE R&D BY MISSION PURPOSE OF NEW ACQUISITION EFFORTS
AUTHORIZE SYSTEM FINAL DEVELOPMENT
AUTHORIZE SYSTEM PRODUCTION
• RECONCILE PERCEIVED NEEDS TO OVERALL AGENCY MISSION CAPABILITIES
• SET INITIAL COST, TIME, CAPABILITY GOALS
• ASSIGN "NEED RESPONSE" TO AGENCY COMPONENT(S)
• PROPOSE R&D BUDGET BY MISSION
• ALLOCATES APPROVED FUNDS TO SYSTEM CANDIDATES FOLLOWED BY ANNUAL REVIEW OF BUDGET AND MISSION NEED
APPROVE FOR COMPETITIVE DEMONSTRATION
APPROVE FINAL DEVELOPMENT
APPROVE FULL PRODUCTION
• SUBMIT MISSION DEFICIENCIES AND PROJECTIONS
• SOLICIT PROPOSALS: SPONSOR PREFERRED CANDIDATES
• FUND ALTERNATIVES ANNUAL REVIEW FIXED-LEVEL FUNDING
CHOOSE SYSTEMS FOR COMPETITIVE DEMONSTRATION
• CHOOSE SYSTEM FOR FINAL DEVELOPMENT UTILIZING TEST AND OWNERSHIP COST DATA
• CONFIRM PRODUCTION DECISION UTILIZING INDEPENDENT OPERATIONAL TEST
USE
SYSTEM CONCEPTS
• EXPLORE ALTERNATIVES WITHIN AGENCY GOALS
PROTOTYPE FABRICATION AND DEMONSTRATION
FINAL DEVELOPMENT
PRODUCTION
TECHNOLOGY BASE
- DIRECTLY AND INDIRECTLY FUNDED
- PUBLIC/PRIVATE/UNIVERSITIES/FCRC'S
- NONCONFIGURED SUBSYSTEMS, COMPONENTS, MATERIALS, ETC.
• UNIFY ACQUISITION POLICY AND MONITORING
①
②
③
④
⑤
⑥
⑦
⑧
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⑫

Source: Commission Studies Program.

bit further, although the Commission on Government Procurement stated that "To improve system acquisition, not only procedureal impediments but also the roles, objectives, and motivations of the participating organizations must be considered," there seems to be very little in depth look at the relationships of roles, objectives and motivations between the participating organizations. As a result, there seems to be little thought given about how to implement the recommendations and what possible resistance there might be to their implementation.

D. GOVERNMENT ACCOUNTING OFFICE

In June 1972, the Chairman of the House Armed Services Committee expressed the Committee's "deep concern over the problem of unforeseen cost escalation in military procurement" and asked the Government Accounting Office (GAO) to "make its own independent study of the bases for cost escalation in procurement contracts."(21:p. 59) The Comptroller General responded with the report Cost Growth in Major Weapon Systems dated March 26, 1973. The report found that 25% of the cost growth was due to estimating errors, 30% was due to inflation and 45% was due to changes in requirements.(21:p. 26)

1. Cost Estimating

Planning estimates, development estimates and current estimates are the three estimates that are provided for a weapons system. The first, the planning estimate, GAO found to be "characteristically low compared with subsequent

developmental estimates." This was felt to be due to lack of definition of the system in the early stages of development and "powerful incentives -- for example, to gain general approval for the new system -- to keep the estimate low." The more mature development estimate was found, in the 45 systems sampled by the GAO, to be 15% greater than the planning estimate. Finally, the periodically updated current estimate provides the most recent view of what the program is to cost. This estimate includes variations for quantity changes, engineering changes, anticipated inflation, cost overruns, estimating errors from the development estimate, etc. The GAO found the current estimate to be 39% greater than the planning estimate and 20% greater than the development estimate in the cases studied.(21:pp. 11-14)

GAO found that in the past cost estimates were frequently based on contractor estimates, which relied almost exclusively on the industrial engineering, or "bottom up" estimating approach. By this approach, the cost of each part of the system, including evaluation of design effort, testing, etc., is estimated and a cost estimate is derived from summing up the costs. GAO recommends the use of parameters of the new system to derive the cost of the new system.(21:pp. 11-14)

2. Greater Capability Demanded

In the view of GAO, "most resources are invested in systems to replace systems to perform the same types of missions. The successive generation of systems which follow

this pattern push state-of-the-art frontiers and, of course, costs increase with each increment of improvement. This technological momentum can be expected to drive costs up no matter how well the programs are managed."(21:p. 15) In a review of 13 weapon systems, GAO found that research and development costs were 5.4 time predecessor costs and unit costs were 4.2 times predecessor costs while performance increased only 1.8 to 3 times the performance of the predecessor. The examples of a 20% cost increase in the SSN 688 propulsion cost over the SSN 637 Class propulsion cost and the greater than 600% cost increase of the MK 48 torpedo over the MK 37 torpedo are cited. The performance changes for these systems are not given.(21:pp. 15-23)

3. Acquisition Management

GAO's criticism of acquisition management centers on revisions to the specifications -- time schedules, quantities or engineering changes. They felt that much of this type of cost growth comes from unrealistic performance targets at the outset of the project. This results, in their view, from challenging the state-of-the-art frontier too much and trying to develop and produce the system too fast, including concurrency (beginning production before full-scale development and testing have been completed).

4. Recommendations

The Comptroller General felt that actions to improve the weapons acquisition process should be aimed at three basic objectives:

- "Making the right decision at the outset on what to develop and for what purpose
- "Applying lessons learned about slippages and overruns
- "Strengthening the overall management of the systems acquisition process."(21:p. 41)

In order to ensure the right decision at the outset, GAO recommends that a consensus be achieved by the Office of the Secretary of Defense, the applicable service and Congress on the operational need, the system characteristics, and the expected level of resources required before commitment to acquisition. Strengthened staff support for the Secretary of Defense to allow more comprehensive and objective analyses of missions and weapons requirements is recommended and strengthening of congressional review by examination of the budget by major missions within each service is espoused.

To apply lessons learned about slippages and overruns, GAO would require weapons system acquisition managers to:

- "Avoid concurrent development and production and adhere to orderly and sequential design, test and evaluation
- "Stress austerity, small design teams, freedom to innovate and maximum competition in the design phase with clear separation of development and production. Encourage continuous development of subsystems.
- "Adopt contracting practices and Government-contractor relationships which will encourage the most effective team performance.
- "Continue to improve the Government's capability to develop cost estimates covering the development phase, as well as the production phase, of new systems.
- "Emphasize life-cycle costing to gain better perspective on proposed new systems and strengthen cost-effectiveness analyses."

Finally, to strengthen the overall management of the acquisition process, GAO recommends that the emphasis on

upgrading the competence, stature and tenure of program managers and procurement specialists be continued and that independent test and evaluation organizations "independent of the user" be established in each military department, reporting directly to the Secretary of Defense or to his deputy. Finally they recommend that one of the deputy secretaries of Defense assume the responsibility for mission analysis and system acquisition.(21:pp. 54-55)

In the author's view, there is no clear tie within the report between the symptoms (cost growth, overdemands on performance and schedule slippage) and the structure that produces them. As a result, the recommendations are of two types: Entreaties to discontinue the symptoms and structural changes that are not related, within the material presented in the report, to the solution of the problem. It is not clear, for instance how strengthening the Secretary of Defense's analysis staff, creation of an independent Test and Evaluation organization and assignment of a deputy secretary to mission analysis and system acquisition will aid in the desire to "stress austerity, small design teams, freedom to innovate and maximum competition in the design phase." It would appear that increasing these staffs would place a greater requirement on the projects for information, requiring the project office to increase its size to provide the information, and decrease innovation by requiring more people to approve the design.

E. SENATOR PROXMIRE

One of the better known and perhaps the most vocal critic of the Department of Defense weapons system acquisition structure is Senator William Proxmire, (D) Wisconsin. In his testimony before the Subcommittee on Federal Spending Practices, Efficiency, and Open Government of the Senate Committee on Government Operation, Senator Proxmire stated:

> "Hundreds of millions of taxpayer dollars are being lost, given away, and literally stolen each year because Government officials from the President down to procurement officers in the Department of Defense are either failing to exercise their legal responsibilities under the law or violating the spirit and the letter of the law."(89:pp. 3-4)

He cites those who feel that cost overruns, gold plating, schedule slippages, performance failures, and bailouts are only symptoms of more basic problems, but feels that search for the original cause is futile for:

> "...in a fundamental sense it does not matter what the origins of our problems are so long as the people with the power to solve the problems are either too weak to use their power or too corrupt to properly use it." (89:pp. 3-4)

In summary, he feels that a lack of accountability on the part of the people in the procurement process and a lack of prosecution of responsible parties are primarily responsible for the problems of weapons acquisition.

He goes on to say that the prevalent attitude in private industry is that "...if you are dealing with the Government you can take as much money as you can get, by one means or another."(89:p. 4) and that the multiple layers of subcontractors, pyramiding costs and profits, provide enormous opportunities for mistakes and abuses under the present

system. In regard to Congress he feels that ".... every time Congress winks at a cost overrun and goes along with a bail-out it is encouraging this kind of behavior."(89:p. 4)

In the way of solutions, Senator Proxmire cites the renegotiation program, with the Renegotiation Board strengthened and the "loopholes" removed from the act, and the Cost Accounting Standards Board, with the depreciation standard upheld. With relation to the recommendations of the Commission on Government Procurement, he particularly supported the proposition that Congress exercise it's responsibilities through greater involvement in key acquisition decisions, that Congress increase its capability to moniter acquisition programs and the funds being spent on them and that meaningful competition be established, starting with the earliest stages of research and development. He felt that the defense establishment should be required to deal with their problems in the fashion a commercial organization or Congress would -- by bringing them out in the open, not covering them up. For officials who were found "incompetent or malicious," dismissal would be the proper response.(89:pp. 6-15)

Early in the testimony, Senator Proxmire made a very telling statement:

> "We in Congress can pressure the executive branch to change their regulations and we can pass new laws until we are blue in our Capitol face. Our efforts will be worthless so long as procurement abuses go uncorrected and so long as procurement abusers go unpunished."(89:p. 4)

In view of this author, if neither pressure nor legislation can be used to solve the problems as viewed by Senator

Proxmire, then the causes must lie somewhere deeper in the existing structure of the weapons acquisition process. Hence to change the performance and conduct of the process will require examination of the structure and how it relates to conduct and performance, followed by a change in the structure with due regard to the effects of the change on all facets of the structure.

These three views of the problems of weapons acquisition represent, in the author's view, a spectrum of the criticism provided by many authors in a large quantity of studies. The List of References provides other resources for the reader who is interested in further pursuing additional atudies in this area.

F. MEASURES OF EFFECTIVENESS

The ultimate measure of the effectiveness of a weapons system is its ability to be used to win a war or to provide a creditable deterrence against war. War is too infrequent and occurrence to be routinely used to measure the effectiveness of a system. Significant data is derived from operational performance and battle damage reports when a war does occur, but another measure of effectiveness (MOE) must be used to evaluate a weapons system in a peacetime environment. For weapons intended for deterrence purposes, one can observe that there is no war, but it is seldom possible to gain other that an inferred insight into how much greater the effectiveness was than the amount needed to deter.

The surrogate measure most commonly used is the operational capability of the weapons system under simulated wartime conditions with constraints applied to the tests as required to ensure safety, to remain within the requirements of the law, to hold costs under imposed budget constraints, etc. This measure of operational capability, along with the number and types of weapons systems in the force determine the material effectiveness of the force. From projected material readiness required to meet perceived future threats and the status of the existing force, a requirement for a new weapon system with a specific set of operational characteristics and a set delivery date can theoretically be derived. Schedule and performance compliance, then, are the two routinely used output measures of the weapons system acquisition process.

The amount of resources required to produce and operate the weapon system is the input measure of the system. This is routinely measured as the purchase price of the weapon system and more recently as the total cost of all resources required to procure and operate the system over the lifetime of the system. Another view of resource use can be gained by observing the utilization of the resources or measurement of the resources expended on the product as compared to the resources used by the process as a whole. The resources may be used not only to produce the weapons system, but to provide for social programs such as equal opportunity, small business assistance and full employment, for maintaining the

industrial base to meet expanded weapons requirements, for the personnal use of the owners of corporations and other people in the weapons acquisition process, etc.

1. Schedule and Performance

The critical point in the schedule is the Initial Operational Capability (IOC) date. This is the date that the weapons system is to be introduced to the fleet. Milestones are established for the development and construction of the system based on this date and are used to provide a measure of compliance during the various phases of weapons system acquisition. Variation between actual accomplishment of events and scheduled accomplishment are indications that either the IOC date will not be met or a variation in resource input is required to meet the date. Unfortunately, in the opinion of some senior personnel associated with the weapons system acquisition process, the IOC date is artifically established and routinely changed. This reduces the credibility of schedule variation as a measure of effectiveness.

Theoretically, the performance characteristic requirements of the weapon system are derived from the mission requirements of the system. Actually, on many occassions the performance requirements are established by estimating the upgrading of existing systems that is possible or the possible output of a new technology. From these performance requirements, a number of specific test requirements are derived to test individual systems, sub-systems

and components. Successful performance is defined as meeting or exceeding the test requirements. Since the requirements are not always related to mission requirements, their value as measures of effectiveness is open to question.

2. Cost

Although the total cost of a weapon system throughout its entire life from inception to retirement (life cycle cost) is the preferred measure, it is seldom used in the actual evaluation of a weapons system acquisition because of the difficulty in gaining data. The establishment of personnel costs and the allocation of system command overhead are examples of difficulties in assigning costs to any specific weapons system. When predictions of life cycle costs are used in system selection and tradeoffs, the process is doubly difficult because of the uncertainties introduced by considering long periods of time. For a ship, the total life can be 20-30 years and a feeling for the difficulty can be derived from considering the ability to predict 1976 prices or force structure in 1936-1946. The problem with using procurement price is that it encourages trading short term gains in construction costs at the expense of long term gains in reduced operating, maintenance or personnel costs. Even procurement costs are difficult to obtain, for every ship uses some government furnished equipment and information, with many ships using significant amounts. These costs are not covered under the prime contract for the ship and are frequently hard to trace to the specific ship. Again like

schedule and performance, the existance of unaccounted costs makes the use of routinely developed cost figures difficult as a measure of effectiveness.

a. Cost Estimating

Parametric estimates, Engineering estimates and Learning Curve estimates are the three types of cost estimates generally associated with weapons system procurement. Parametric estimates are derived by extrapolating costs from the actual costs of previous systems and correlating these costs with physical or performance characteristics of the system. Examples of the characteristics used are speed, range, displacement and horsepower. Engineering estimates are derived by summing the estimated costs of the detailed components of a system. The estimated cost of the detailed components may be obtained from analysis of specific work to be performed, experience on similar components or by parametric estimates of detailed components. Learning curve estimates apply to items that are produced in quantity and are made by extrapolating the actual cost of precious units based on the assumption that a proportionate reduction will take place as production continues.

Parametric cost estimates are best when there is limited design information available for a particular system and is the only feasible method prior to or during the concept formulation phase. Parametric estimating has difficulty in accounting for changes in technology between system, such as a shift between the use of aluminum and

titanium, the latter being much more expensive per pound. The more expensive Engineering estimate requires detailed information, hence can not effectively be done until detailed proposals have been received. It is then still subject to the uncertainties that the design itself experiences, but has the potential of being a great deal more accurate than the parametric estimate. Learning Curve estimates have proved to be very accurate in large production run situations. They do require previous production of the same product, hence are generally inapplicable to early program estimates except in computation of expected reduction in the cost of follow units. A problem common to all methods of estimating is that they rely on past information, thus past inefficiencies are reflected in the estimates of the new system. Even if they were entirely accurate, they rely on a certain quantity of the system bought at a specific time. When the quantity purchased or the schedule changes, the estimate will be wrong.(35:pp. 156-157)

Biases may be introduced into a cost estimate either inadvertently or by design. Market sensitive or unscrupulous contractors can purposely "buy-in" on a contract by providing a low bid, intending to make the overall contract profitable through the funding of changes they feel the Government will surely make. Transferrance of technical information between contractors and conceptual specifications that are too tight lead to competition on price alone, which encourages "buy-ins." Lean defense procurement budgets invite optimistic

estimates to get the program started, based on the feeling that once started programs are seldom cancelled. Finally, the general optimism found amongst most development groups and program advocates has a tendency to lead them to underestimate the risks envolved in the program, resulting in low cost estimates with insufficient allowance for unknowns.

b. Cost Growth

Cost growth is neither new nor unique to weapons systems. In ancient Rome, based on the works of Edward Gibbon, "... the young magistrate, observing that the town of Troas was indifferently supplied with water, obtained from the munificence of Hadrian three hundred myriads of drachms (about a hundred thousand pounds) for the construction of a new aqueduct. But in the execution of the work the charge amounted to more than double the estimate, and the officers of the revenue began to murmur.." Fortunately for the young magistrate, Julius Atticus met all of the extra cost out of his pocket, silencing the wrath of the revenue collectors. Today, with no Julis Atticus around, the taxpayer must bear the brunt of cost overruns.(79:p. 2)

In more recent times, a contract was awarded by a public utility for the delivery of a reactor core within four years for $55 million. As of the original delivery date, the manufacturer had run out of money and was not able to make delivery. The reactor core was delivered several years later and the cost overrun was some 200% of the original price.(79:p. 4) In the public arena in recent

years, the cost overruns in the Rayburn Annex to the House of Representatives Office Building are classic.(79:p. 4) Even the Library of Congress is not exempt from cost growth. The library's new James Madison Memorial Building is presently up to 160% of its initial cost estimate and hasn't yet been completed. As an interesting aside, there is presently a difference of opinion concerning the use (or operational requirements) of the building.(68:p. 26) As described later this change in operational requirements is a problem common to weapons systems.

The three major direct causes of cost growth in a weapons system are low cost estimates, inflation and system and program changes.(21:p. 26) In the author's view, cost growth due to estimating is apparent cost growth which depends only on the state-of-the-art of cost estimating. If this were the only cause of growth and the state-of-the-art in cost estimating were to increase to the point where accurate cost estimating was achieved, all of the original inefficiencies of the weapons acquisition process would remain. It is cost growth, however, that brings a major share of the "bad press" received by weapons system acquisition. It behooves the organizations within the weapons acquisition structure, therefore, to do something about cost growth, whether real or apparent, to ensure the proper allocation of resources and the most effective and efficient use of these resources.

c. Inflation

General inflation will result in inflation in the weapons acquisition process. This is based on the fact that organizations involved in the development and manufacture of weapons systems must compete in the market place for material, services and finances with the civilian sector of the economy. When the prices for goods that are common to both markets go up, the prices for goods required by the weapons systems producers will also go up. In addition to this, there are limited facilities capable of producing some types of defense systems. When these are in demand heavily by the civilian sector, as was the case with shipyard space when tanker construction was at its peak in the late 1960's and early 1970's, inflation 2 to 3 time the national rate may be experienced in some sectors of weapons acquisition.

When tight defense budgets or technical problems delay a program, the effects of inflation are felt to an even greater extent. If it takes 4 years to build a system and 10% annual inflation is assumed, labor and material costs will be 46% higher in the fourth year than in the first year. If the program slips, for any reason, to 5 years, the costs will be 61% higher than they were in the first year. Hence inflation acts not only to increase the costs in its own right, but magnifies effects of schedule changes as well.

3. System and Program Changes

The system and the program may be changed to take advantage of technicological advances, to fix errors, to

respond to mission changes or to accomodate resource changes. Any one of these changes normally affects cost, schedule and/or performance. The magnitude of the effect on each will be a function of the relative utility of meeting cost, schedule or performance goals within the structure of the acquisition process.

Technicological improvement routinely take place in a given field over a period of time. Hence the second generation of a weapons system performing essentially the same mission as its predecessor can be expected to take advantage of the improvement in the state-of-the-art unless some external constraint is imposed. A major difference between a ship and most other weapons system is the time required for design and construction. The longer time required for ship design and construction means that state-of-the-art advances can be expected to occur throughout the process. The system acquisition organization is then faced with the decision to either accept a ship with technology that is several years old upon delivery or accept the consequences of disruption in the production process by incorporating changes before delivery.

Design problems, manufacturing problems and supplier problems can all cause disruption in the system or program. The design and manufacure of a ship is such a complex task that there will almost certainly be human error which will result in the need for a "fix." Depending on the magnitude of the error, there can be a significant effect on cost,

schedule and/or performance. Most of the components used on a ship and many of the systems are manufactured at some location other than the shipyard, usually by some manufacturer other than the shipbuilder. This provides the potential for schedule slippage and/or cost increase when the equipment does not arrive in time to support the installation schedule.

The mission of the weapons system may change because the threat for which it was designed changes, because interpretation of the threat changes or because the mission was not adequately defined before the process started. If the threat changes, the weapons system acquisition organizations are faced with the alternative of either modifying the mission, therefore the operational characteristics, of the weapons system or finding some other way to meet the revised threat. The usefulness of the system in its present configuration must be weighed against the cost of modification and a decision made. The ability to start an entirely new system and have it operational to meet the revised threat in a timely manner is also considered. In some cases, changes in senior personnel in the acquisition process will result in a different view of the threat. This can markedly change the mission requirements and specifications of a ship. Finally, if the mission is not adequately defined, its later definition in the procurement process may result in changes in operational requirements -- with changes in equipment and configuration the natural result.

A change in the resourses available to the process will have a direct effect on the resultant output. As an example, decrease in appropriations for the program or a decrease in available construction facilities will generally result in a schedule slippage and a cost increase. A less obvious example is that decreased manning in the Navy may result in less personnel available to man the ship. This means that allowance must be made for a smaller crew, less watchstanders and/or maintenance personnel and more automation and maintainability -- all factors which directly impact on design.

II. VIEWS OF ORGANIZATIONS

In order to explore the dysfunctions of the ship aquisition process, a theoretical framework of the structure of organizations must be established. This chapter will establish the correlation between the structure, conduct and performance of large organizations. The applicability of specific structures to certain types of tasks will be examined.

A. BUREAUCRACY

1. History and Definition of Bureaucracy

One of the first management theorists was Henri Fayol, a French industrialist, who in 1916 published his observations in Administration Industrielle et Générale. In this work he put forward his fourteen principles of effective management. These included the division of work, the definition of authority, the requirement for discipline, the necessity of unity of command and direction, the subordination of individual interests to general interests, centralization, chain of authority and other values considered necessary to the optinum operation of an organization. In 1937, following the pattern established by Fayol, Luther Gulick and Lyndall Urwick popularized such principles as fitting people to the organization structure, recognizing one top executive as the source of authority, adhering to unity of command, using special and general staffs, departmentalizing by purpose, process, persons and place, delegating and utilizing the

exception principle, making responsibility commensurate with authority and considering appropriate spans of control.(48:pp. 58-60)

The real father of the Bureaucractic analysis was Max Weber, a member of the staff of the University of Berlin. His real contribution to the study of organizations was his theory of authority structures. His interest in the reason why people obeyed commands led him to make a distinction between power, the ability to force people to obey, regardless of their resistance, and authority, where orders are voluntarily obeyed by those receiving them. Under the authority system, the issuance of directives by a superior is seen by those in a subordinate position as a legitimate exercise of that role. Organizational types were then characterized by the way that authority was legitimized. Weber recognized three pure types: "charismatic," which depended on the qualities of the leader to set himself apart from other men, "traditional," which depended on precedent and usage, and "rational-legal," which depended on a well understood organizational goal and formal rules. The "charismatic" form of an organization was typified by a small scale revolutionary movement either religious or political in form. The early factories of Henry Ford and the beginnings of the Office of Naval Reactors displayed many of the attributes of this form of organization. The patrimonial and feudal forms of organizations are dependent upon the traditional form of authority. Although these are

typical of forms of government no longer commonly gound, they are not untypical of some family owned corporations. The rights and expectations of the group are established in terms of taking what has always happened as sacred, depending upon custom to regulate the system.

The term "Bureaucracy" was used to describe a form of organization based on the rational-legal form of authority. The system is "rational" because the means are expressly designed to achieve certain specific goals. It is legal because authority is exercised by means of a system of rules and procedures through the office which an individual occupies at a particular time. Contrary to the popular usage of the word as synonymous with inefficiency, an emphasis on red tape, and excessive writing and recording, Weber states that a bureaucratic organization is technically the most efficient form of organization possible. Precision, unambiguity, speed, knowledge of files, discretion, continuity, unity, strict subordination, reduction of friction and minimization of material and personal costs all reach an optimum point in the strictly bureaucratic administration.(75:pp. 19-22) Weber's work has served as a point of departure for many organization theorists. Richard H. Hall, for instance, suggested that bureaucratization is a continuim whose degree can be determined by measuring the following six dimensions: division of labor based upon functional specialization, definition of the heirarchy of authority, the completeness and exactness of the system of rules covering the rights and duties of positional incumbents, the scope and depth of

the system of procedures for dealing with work situations, the impersonality of interpersonal relations, and the formality and adherance to a system of promotion and selection for employment based upon technical competence. In the "ideal bureaucracy" these dimensions would all exist to a high degree, where a less bureaucratic organization would have them to a lesser degree. Study of large-scale, complex organizations indicate that these dimensions are always present in varying degrees.(48:p. 64) Given the presence of these dimensions, their advantages and disadvantages to the ship acquisition process must be examined.

2. Advantages and Disadvantages of Bureaucracy

Max Weber's view of the principle advantage of a pure bureaucracy is:

> "Experience tends universally to show that the purely bureaucratic type of administrative organization-that is, the monocratic variety of bureaucracy-is, from a purely technical point of view, capable of attaining the highest degree of efficiency and is in this sense formally the most rational known means of carrying out imperative control over human beings. It is superior to any other form in precision, in stability, in the stringency of its discipline, and in its reliability. It thus makes possible a particularly high degree of calculability of results for the heads of the organization and for those acting in relation to it. It is finally superior both in intensive efficiency and in the scope of its operations, and is formally capable of application to all kinds of administrative tasks." (93:p. 24)

With regard to the people operating within such an organization, there can be no question in their minds just where they stand within the heirarchy, what they must do to advance, and the exact requirements of their job. This approach will provide the "rational" man with the comfort of the security derived from a certain situation.

The first major drawback to the bureaucratic approach to organization is its dependence on a constant task to accomplish. An organization perfectly designed to do one task will be less efficient in doing any other job. A direct analogy can be drawn to a machine specifically designed to do one job. Although it may be more efficient and less costly than any other way of doing that job, it fails miserably when required to accomplish some other task. When the machine is designed to be capable of adaptation to several jobs, efficiency is lost in the specific accomplishment of a single job. This may be overshadowed, or at least offset, by the reduction in capital investment realized when the machine is capable of handling changes in the product manufactured. The organizational equivalent is the saving realized in not having to retrain the workers as the product changes.

The second major drawback to a bureaucratic system is the requirment for a constant input to the system. This implies that the environment, as viewed by the organization must remain constant. As a result, organizations must "buffer" themselves from environmental influences, anticipate those environmental changes that cannot be buffered against and ration their resources when the environmental influences cannot be controlled. The organization necessary to do this is clearly "overhead" though it is not clear whether a "buffered" bureaucratic organization is more efficient in handling changes in the environment than one specifically designed to handle a wide spectrum of environmental changes. It is the

author's hypothesis that this would depend upon the rate and magnitude of the change.

A third factor which throws doubt on the viability of the bureaucratic approach is the nature of the organizational members themselves. A bureaucratic system assumes that people can be found that exactly fit the requirements of the position in the heirarchy and that they will act entirely in accordance with the organization's desires. The studies of numerous researches have shown that the conflicting roles of the individuals within the organization make the belief that individuals can be made to work like well oiled machines is a naive approach at best. James G. Marsh and Herbert A. Simon also identify the fact that there are limits to an individuals cognitive abilities which restrict the extent to which he can make rational decisions in or out of the organizational context. Thus an individual has a tendency to "satisfice" instead of optimizing, which results in something less than the totally rational approach.(44;pp. 14-22) These three factors cast doubt on the applicability of bureaucratic organization to the weapons acquisition process.

B. STRUCTURE, CONDUCT AND PERFORMANCE RELATIONSHIPS

1. Relationships

Graham T. Allison describes three basic conceptual models that can be used to describe the operation of a large organization. The first model, the Rational Policy Paradigm, explains conduct as a group of actions chosen by the organization. Under this model, the organization selects

actions that will maximize the goals and objectives of that organization. Although this type of model is frequently used by analyists, it assumes a unity of purpose within an organization that is seldom found. The second model is the Organizational Process Model. Under this model, organizational behavior can be understood as the output of the organization functioning according to standard patterns of behavior. In order for large numbers of individuals to accomplish a complex task there must be coordination. Coordination, in turn, requires the use of standard operating procedures: rules according to which things are done. "Programs" must be established to assure the reliable performance of action that depends upon the behavior of hundreds of people. The Bureaucratic Politics Model is the third type used by Allison. In this model, the decisions and actions of a large organization are essentially political outcomes. What happens is not chosen as a solution to a problem but rather results from compromise, coalition, competition and confusion among organization officials who see different faces of an issue. It is considered political because the activity from which an action is derived can be best described as a bargaining process.(1:pp. 689-711)

The structure of a process is made up not only of the formal organization of the players in the process, but of all the rules that govern their performance. Hence in each of Allison's models, knowing the structure in which the decisions are made provides an ability to predict the outcome

of the process. With a predictable outcome, or conduct, we can compare this conduct to some theoretical optimum to evaluate the performance of the process. Structure, conduct and performance are thus inexorably tied together. If we are dissatisfied with the performance of a process, we must make changes in the structure of the process to achieve any real change in the performance.

2. Strengths and Weaknesses of the View

The greatest strength of the view that structure generates conduct which can be measured in terms of performance is that it works. Structures have a strong tendency to produce predictable conduct and performance that is based on the form and details of the structure itself. Further, by modifying the structure of a process involving large organizations, the conduct and hence the performance is changed. The converse is generally not true. Attempts to modify the performance without modifying the structure are not generally successful. On the other hand, modifications made to the structure without fully considering all of the facets of the structure and their relationships frequently results in performance other than that which was desired when the modification was made.

The weakness of this view is that the model looks at an aggregate of the process as a whole and doesn't allow for the individual differences of the personalities of the players. This can provide a certain sense of futility to a person in the lower level of the organization who must live

within the structure without any real power to change it. The model also explains the mean performance and, while allowing for observed variance from the mean, has a tendency to neglect the exceptions to the "rule." Structural changes which may improve the system as a whole by improving a number of the elements of the structure may degrade other segments of the structure by overly restricting their freedom to operate.

3. Results of Changes

The magnitude, character, source and rate of change all effect the results of a change to the structure of a process. A large organization exibits significant inertia that has a tendency to resist change and if change is thrust upon it, it either builds a buffer mechanism to reduce the effects of the change on the organization or accomodates itself to the change in a fashion designed to cause the least disruption in the organization.

That the results of major changes of structure, like the creation of large project offices for the development of POLARIS and nuclear propulsion would have a significant effect on the conduct of their development comes as no surprise. What is of greater interest is the effect of relatively minor changes like the addition of the requirement for environmental impact statements. Though these may only be a vehicle for getting some other job done, some of the smaller changes to the structure can have far reaching effects upon the conduct of a process.

Changes that evolve from natural changes in technology or as a natural result of market forces are much more easily accepted into the system than changes imposed on the system. In the latter case, the general question is of the legitimacy of the authority of the superior to order a change of the type or scope of the one ordered. The introduction of rocket technology met far less resistance than the attempt by Admiral Zumwalt to introduce sweeping social change into the Navy.

C. VIEWS OF ORGANIZATION

1. Bureaucratic Model

There exist, in the concepts of Max Weber, eight requisites for "legal authority." These are required to have a truly bureaucratic organization. The requirements were:

(1) A continuous organization of official functions bound by rules.

(2) A specified sphere of competence, which included obligations to perform functions which were marked off as part of a systematic division of labor, the authority to carry out the functions and a clearly defined and controlled "means of compulsion."

(3) An organization of offices following the principle of heirarchy. This was considered to have a system of appeal, however.

(4) Rational rules which regulate the conduct of an office.

(5) Separation of the means of production or administration from the membership of the administrative staff. Officials, employees, and workers attached to the administrative staff do not themselves own the non-human means of production and administration.

(6) There exists no "right" of an individual to a certain office.

(7) Administrative acts, decisions and rules are formulated and recorded in writing.

(8) The Purest exercise of legal authority is through the the use of a bureaucratic administrative staff, but other forms of administration can be used to exercise legal authority.(93:pp. 19-21)

These traits are generally considered independent and can obviously not be found in their entirity in any specific organization, but can conceptially be used as yardsticks for measuring how "bureaucratic" an organization is. This author has found no specific to measure of the traits or way to combine them, but a relative "feel" can be obtained. Assumed within the entire philosophy is the fact that the organization has some specific purpose and the organization is operating to accomplish that purpose.

The Bureaucratic Model represents one pole of a continuum of organization types, that can be applied to acquisition of a ship. The other pole of this continuum is the Open System Model.

2. Open System Model

The next major revision in thinking about how an organization should operate came from the behavioral sciences. Called an open or organic system, it was contrasted against the bureaucratic system. In this context, the bureaucratic system is referred to as a closed or mechanistic system. The emphasis was placed on human factors and the way people behave within an organization instead of concentrating on the structure and task inherent in accomplishing the purpose of the organization.(48:p. 77) The organization is viewed

as a transformation system that takes various inputs, changes them and provides an output. The open system is considered to be in continual interaction with its environment, achieving a dynamic equilibrium with continual inputs of people, material, money and ideas. It was further recognized that the people within the organization brought with them the effects of roles they had outside the organization. Hence a person could not be considered just a "foreman," but also had to be considered a father, a Boy Scout leader and a member of a specific church.(48:pp. 109-111) The needs of the individual were examined across the spectrum of his whole life instead of just looking at his role within the organization.

As with the bureaucratic model, it was not felt that the open system ever really existed in reality, but served to act as a yardstick against which an organization could be measured. Bertram M. Gross set forth the following goal for an open organization:

> "The performance of any organization or unit thereof consists of activities to (1) satisfy the varying interests of people and groups by (2) producing outputs of services or goods, (3) making efficient use of inputs relative to outputs, (4) investing in the system, (5) acquiring resources, and (6) doing all these things in a manner that conforms with various codes of behavior and (7) varying conceptions of technical and administrative rationality." (48:pp. 161-162)

This model was, however, considered as a desirable objective for all organizations. Recognizing that the goals of the various participating groups in an organization are frequently in conflict and that it is rarely possible to maximize

the goals of any one individual or group, it was felt that an organization should "satisfy" the goals of all participants in order to maintain their participation.(48:pp. 162-163) The open system model provides the other pole of the continuum of possible organizations applicable to weapons acquisition. Neither is considered viable, but are only used to illustrate the ends of the scale.

3. Mixed System Model

Other management specialists feel that neither the bureaucratic model nor the open system model is the "answer" to "proper" management of an organization. Rather, they feel that the task being accomplished by the organization must dictate the structure of the organization. They feel that an organization that exibits more bureaucratic traits is the proper one for a high volume, low change production process. A system that is more open is appropriate in answer to a low volume demand of a highly variable nature. The open system provides the ability to handle a high rate of change, unproven and uncertain techniques and a large number of continencies.

If an innovative thrust is desired within an organization while continuing to achieve the economies of bureaucracy, a mixed system is desirable. Some portions of the organization would be structured as a bureaucratic system while others would operate as an open or organic system. Typically, the research and development effort would be structured along organic lines. These organic sections are characteized by the devolution of staff services to the specific line

organizations, decreasing relevance of rules and regulations covering non-productive functions, high individual skill levels with more dependence on "professionalism" and a more decentralized control of the groups within the section. The production effort, on the other hand would be more bureaucratic. There would be specific rules covering working hours, a highly delineated chain of command and narrowly defined responsibilities. Other tasks would require structure somewhere on the continuum between these two. A machine shop working on short run job orders should not be structured like either an automobile production line or a research laboratory, but should be somewhere in between the two.

Variability and analizability are variables used to define the degree of uncertainty of the task to be accomplished by an organization. The first, "variability or stimuli" is a measure of the number of non-routine inputs to the organization. When a familiar order is received, the recipiant knows "exactly" what to do, hence requires no "search behavior." If the stimuli is unfamiliar, the recipient must "search his mind" for the response.(73:p. 76) Thus an increase in "variability of stimuli" (or exceptions to the routine) results directly in an increased "search behavior." The degree to which search procedures are analyzable is another variable of a task to be accomplished. If the response to the stimuli is known or can be found by a set routine such as finding it in a book or retreiving it from a computor, the method of analysis is analyzable. If

innovation or intuition is required, then the task is unanalyzable to the degree that this trait is necessary to accomplish the task. If these two variables are cross-classified we can define tasks as craft, nonroutine, routine and engineering. Figure 4 shows the relationship between the variables and these decisions. The manufacture of automobile distributor caps (cell 4) is an example of a routine task that requires an analyzable search and experiences few exceptions. The design of made to order, proven technology machines, like drill presses and electric motors, is an example of an engineering task (cell 3). The manufacture of fine glassware is an example of a craft task (cell 1) as the operation is quite routine, but a great deal of intuition is require to achieve the proper mix of glass and handle it properly. Finally, the development of a laser weapon system is a non-routine task (cell 2).(73:pp. 75-80)

The appropriate response to the variation in task type is a variation in the structure of the organization responsible for the accomplishment of the task. The structural characteristics chosen by Charles Perrow to describe the structures applicable to each task are: the discretion of subgroups; their power; the basis of coordination within a group; and the interdependence of individual groups. Within a given task type, the structure is not generally the same for middle management, which is defined as the people who are concerned with the supervision of production. Figure 5 shows the structural characteristics that Perrow felt were

Variability of Stimuli

	Few Exceptions	Many Exceptions
Unanalyzable Search	Craft 1	Nonroutine 2
Analyzable Search	4 Routine	3 Engineering

Figure 4 - Technology Variables

	Discretion	Power	Coordination within Groups	Interdependence of Groups	Discretion	Power	Coordination within Groups	Interdependence of Groups
		Craft				Nonroutine		
Middle Management	Low	Low	Planning	Low	High	High	Feedback	High
Lower Management	High	High	Feedback	Low	High	High	Feedback	High
		Control: Decentralized				Control: Flexible, Polycentralized		
		Routine				Engineering		
Middle Management	Low	High	Planning	Low	High	High	Feedback	Low
Lower Management	Low	Low	Planning	Low	Low	Low	Planning	Low
		Control: Formal, Centralized				Control: Flexible, Centralized		

Figure 5 - Relationship of Task to Structural Characteristics

appropriate to the various tasks. In a nonroutine organization both discretion and power are high in middle and lower management. Coordination is through feedback (mutual adjustment) rather than through advance planning (programmed) and, finally, the interdependence of the groups is high.(73:pp. 80-39)

Another observation of organizations is their tendency to move toward a bureaucratic structure. One explanation for this is that as the size of an organization increases, there is a need for more coordination. This can lead to a more formalized communication system and more specific descriptions of the tasks to be accomplished by each group. Further, if economies of scale are to be realized, a shift to the use of less skilled personnel is required. This requires a limitation in the freedom of action of the worker which leads to more "rules."(73:pp. 50-91)

Under this view of an organization, five types of goals are distinguishable:

(1) Societal goals. Referent: society in general. Examples: produce goods and services: maintain order: generate and maintain cultural values.

(2) Output goals. Referent: the public in contact with the organization. This category deals with types of output defined in terms of consumer functions. Example: consumer goods; business services; health care; education.

(3) System goals. Referent: the state or manner of functioning of the organization, independent of the goods or services it produces or its derived goals. Example: the emphasis upon growth, stability, profits, or upon modes of functioning, such as being tightly or loosely controlled or structured.

(4) Product goals (or more exactly, product-characteristics goals). Referent: the characteristics of the goods or services produced. Example: an emphasis upon

> quality or quantity, variety, styling, availability, uniqueness or innovativeness of the products.
>
> (5) Derived goals. Referent: the uses to which the organization puts the power it generates in pursuit of other goals. Examples: political aims; community services; employee development; investment and plant-location policies which affect the state of the economy and the future of specific communities. (73:pp. 135-136)

A final point is that this view of organizations also represents a continuum. A task requiring custom craftsmanship falls somewhere between the craft and nonroutine categories. Even within a category there can be a variation, as one could say that the manufacture of airplanes is less routine than the continuous processing of oil or chemicals. (73:p. 82)

Another type of mixed organization is the "mattrix" organization. In this type of organization, managers are assigned to each functional group and to specific products. The product (or project) managers responsibility extends across all functions that are required for his product. This form of organization has the advantage of having one manager directly responsible for a specific product but provides complicated lines of communication and authority.

4. Quantification of Government Bureaucracy

An attempt has been made by Malcolm Dole to approach the government as a "firm," whose decision makers attempt to maximize a utility function subject to some specific constraints. He assumes "equal ownership" of the "firm," with each voter having one vote, and uses "efficiency" and "personnel" as his two decision variables. The public

decision maker is presented as having a utility function containing these two variables. Efficiency is defined as the difference between value created and value foregone in the allocation of the bureau's budget. Because the benefits of actions in the public sector are rarely measurable, the level of output is assumed given to the bureau and efficiency is attained by minimizing the cost of attaining the output.

Since efficiency is obviously not the only variable influencing the government decision maker, there had to be some other factor. Possible candidates were power, prestige, patronage, security, salary, ease of workload, agency bigness and growth, etc. Because of the complexity of an analysis in the face of the number of possible variables, personnel was chosen as a surogate measure that best represented these other variables. Personnel is defined as the number of personnel supervised by the decision maker. Although there is no direct relationship, there is enough correlation between the number of people supervised and the budget, prestige, power, flattery, patronage, security, salary, promotion and advancement of the decision maker to make it a reasonable proxy for the other attributes.(33:pp. 6-18) Given these two variables, an economic analysis is conducted to describe the actions of a government bureau.(33:pp. 6-18)

In the view of this author, minor difficulties arise from the assumptions that all voters have equal power over the "firm" and that the output of a bureau is given. The existance and effect of power groups and the variation in

services received from many bureaus make these assumptions difficult to support for anything other than a theoretical analysis. A graver problem can be seen in the assumption that the bureau works in a rational fashion to achieve the maximization of the utility function. Too many public officials have decried their inability to accomplish their goals , to believe that they succeeded in maximizing. This is believed by the author to be due to frequently hidden constraints such as the inability to exert sufficient influence on the bureau's unweildy structure or the requirement to negotiate with some other bureau with conflicting and sometimes hidden utility functions. The proof of a model, however, is in its ability to predict and Dole's economic model of a bureaucracy does indeed describe general trends.

5. A Popular View

The popular view is perhaps best characterized by the works of C. Northcote Parkinson and Lawrence J. Peter. Parkinson's Law and The Peter Principle have become phases in everyday use in the United States in the description of large organizations, particularly the government. Parkinson observes that "work expands so as to fill the time available for its completion," "the number of the officials and the quantity of the work are not related to each other" (the number of officials increasing without respect for the job to be done), "the time spent on any item (of budget) of the agenda will be in inverse proportion to the sum involved," and that a committee, like a plant "takes root and grows, it

flowers, wilts and dies, scattering the seed from which other committees will bloom in their turn."(72) These traits, along with the others described by Parkinson, are all too often observed by anyone who has been in a large organization not to lend credence to them. The "Peter Principle" that "In a hierarchy every employee tends to rise to his level of incompentence" has also been observed by most of us.(74:p. 25) Both of these are really descriptions of observable phenomenum and, in the author's view, fail to provide sufficient central theory to develop an adequate explanation of the structure and conduct of a large organization.

D. VARIABLES

If an organization or group of organizations is viewed as a system, then a system boundry may be described. External to the boundry, the environment provides the inputs to the system, accepts the outputs of the system, gives direction to the system and provides feedback based on the output of the system. Inside the boundry the system may be broken into the organization contained and the task it is accomplishing. With this sort of division, the organization, the tasks and the environment can be described in terms of variables that will describe each of the major elements.

The following are some of the potential variables affecting the weapons acquisition process as practiced by the organizations involved. Some of the listed variables are directly quantifiable, for example the size and number

of levels in an organization. Others are subject to qualitative investigation, like the accuracy and timeliness of information flow, but defy ratio scale description in "number of errors and omissions per communication" for instance. Still others, like adaptiveness, have no unit of measure other than subjective evaluation represented by an ordinal scale.

1. Organizational Variables

Variables that may be used to describe organizations associated with the weapon acquisition process are:

-- Size: The number of people directly employed by the organization.(44:pp. 112-119)

-- Levels: The number of layers of management.(48:p. 214)

-- Organizational Complexity: The number of individual organizational subunits summed over all levels of the organization.(44:p. 143-149)

-- Shape: The type of management used, varying on a scale between bureaucratic and open, including mixed system, decentralized control, etc.(48:p. 101)

-- Core system technology: The type of task around which the organization is built, varying between continuous process and a individual tasks (where each task is different).(48:pp. 180-188)

-- Age: The length of time that an organization has been in operation, measured in years.

-- Rate of Management Turnover: The number of changes of management personnel per year, per operating cycle or during the duration of the project.(57:p. 120)

-- Organizational goals: The objectives for which the organization is striving
(1) Social: value to society in general
(2) Output: value to those who receive the output of the organization directly
(3) System: smoothness of system functioning
(4) Derived: use of power generated for other goals (73:p. 135-136)

-- Internal Feedback: The clarity and frequency of status information flow from within the system relating to the results of actions taken.(44:pp. 273-287)

-- Permanance: The length of time that an organization can be expected to remain in existance. This variable generally relates to an organization created to accomplish a specific set of tasks with the expectation that the organization will be dissolved when the tasks are complete.

-- Adaptiveness: The ability of an organization to change its structure to meet changes in the environment or the tasks it is required to accomplish.

-- Staff/Line ratio: The number of people with staff functions compared with the number of people assigned tasks required for production of the designed output of the organization.(48:p. 213)

-- Organizational Dependence: The extent to which an organization is dependent on other external organizations to accomplish tasks assigned.(59:pp. 61-63)

-- Physical Barriers: The physical proximity of the members of the organization to each other and to those exercising control over the organization. (73:p. 115-116)

-- Formality: The degree to which operations are controlled through formal communications. A measure of the use of formal, recorded communications vice informal, unrecorded communications such as telephone conversations and informal meetings. (44:p. 68)

-- Control: The degree to which superiors control the actions of subordinates. This may be observed by the freedom subordinates have in expenditure of funds, setting production goals, observance of rules and directives, etc.(57:p. 57)

-- Information flow: The accuracy and timeliness of information flow from the source to those who need the information to accomplish their function.(44:pp. 283-293)

-- Political power: The ability of an organization to obtain the desired resources. This measure is applicable to an organization embedded within a bureaucracy and not subject to the normal market relationships.(33:pp. 6-18)

-- Interface size: The number of people dealing with external organizations.

2. Task Variables

The kinds of variables that can be used to describe the tasks accomplished by the weapons system acquisition structure include:

-- Value: The worth of the task being done. This is variously considered in terms of cost of the product, budget for accomplishing the task, budget for the task in relation to some standard (DOD Budget, total Federal Budget or GNP) or the utility of the task in relation to alternative uses of the resources.

-- Duration: The length of time required to complete the task.(59:p. 115)

-- Task Complexity: The number of different disciplines required to accomplish the task (physicists, mechanical engineers, accountants, etc.).(57:p. 120)

-- Risk: The amount of uncertainty involved in accomplishing the task from internal or external sources. It may be expressed in probabilities that unforeseen changes will take place before the task is complete.(57:p. 117)

-- Difficulty: The degree of technicological or scientific advancement required to accomplish the task. This dimension varies from the requirement to go through the entire development process to the installation of existing equipment in a routine fashion.(73:pp. 76-80)

-- Task differentiation: The degree to which product (ship, airplane, etc.) differs from others capable of performing the same function (mission).(15:pp. 18-22)

-- Visibility: The amount of coverage by outside organizations (news stories, editorials, investigations, etc.).

-- Chain length: The number of people that a communication must pass through to accomplish a task. (44:pp. 269-273)

-- Approval pyramid size: The number of people who must approve the task or its method of accomplishment to have the authority to do the task. The number of

people within the organization who provide opinions relating to approval or disapproval must also be considered.

-- Task dependence: The extent to which completion of a task or sub-task is affected by other tasks or sub-tasks.(59:pp. 61-63)

3. Environmental Variables

The principle contributor to the environment of each organization involved in the weapons acquisition process is the other organizations involved in the process. If the organizations within the weapons system acquisition process are viewed as a system of organizations, then a significant part of the environment for the systems remains other organizations external to the system. As a result, the variables of the type used to describe organizations within the weapons system acquisition structure can also be used to describe those external to the structure. If a variable has an effect on the conduct of an organizational external to the weapons system acquisition structure and that organization has an effect of the structure, then the variable becomes an environmental variable as viewed by the structure. The effect of the variable on the structure may be of a different magnitude or direction than its effect on the organization external to the structure.

Variables that may be used to describe other facets of the environment are:

-- Types of inputs and outputs: The characteristics of the resources provided by the environment to the organization and of the output produced by the organization.(44:pp. 298-300)

-- Competition for inputs: The number of uses for resources desired by the system other than the system itself.(73:pp. 127-130)

-- Competition for outputs: The number of uses for outputs of the system.(73:pp. 127-130)

-- Political climate: The value of the system and the tasks it accomplishes as perceived by the people within the environment.(44:pp. 301-302)

-- Economic conditions: The general health of the national and world economy.(44:p. 302)

-- External Feedback: The clarity and frequency of status information flow from sources external to the system relating to the output of the system.

-- External Control: The type and frequency of commands or directives from sources external to the systems.

E. THE APPLIED STRUCTURE, CONDUCT AND PERFORMANCE FRAMEWORK

In the view of the author, a synthesis model containing the Rational Policy Model, the Organizational Process Model and the Bureaucratic Politics Model is required to explain the structure and conduct of an organization. The Rational Policy Model can be used to explain the formally promulgated goals set by an organization. It is against the standards of these Rational Policy Model goals and society's overall goals that the performance of the organization can be measured. If the output of the system in relation to the resources used is not commensurate with these standards, then the system is either operating ineffectively, operating inefficiently or there are other goals toward which the organization is striving.

As the number and complexity of the tasks being done by an organization increases, the complexity of the organization must be increased to continue to do the tasks required.(48:p.196) With the increased complexity, problems of communication and coordination build, requiring routinization of repetitive portions of the tasks being done and the creation of a bureaucracy. The Organizational Process Model describes the

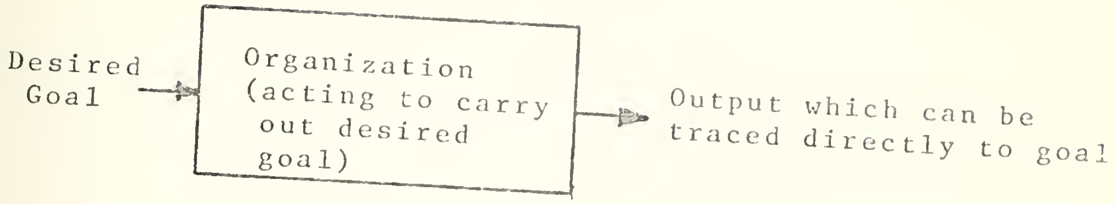
operation of an organization in terms of its structure. Given the structure of an organization, the conduct of that organization on a given task is, in the opinion of the author, reasonably predictable. When conduct and results are measured against the theoretical inputs and outputs of the Rational Policy model, a measure of the performance of the organization or system may be derived. This chain of structure, conduct and performance is the central theme of the author's view of the operation of the system that produces weapons system.

Situations exist where neither the Rational Policy Model nor the Organizational Process Model Adequately describe the actual performance of an organization. The Bureaucratic Politics Model, in the view of this author, describes this variation reasonably well. Variation, in this perspective, comes from the suboptimizations of compromise, coalition, competition and confusion. The three models are illustrated in Figure 6. These effects, though not designed into an organization, must none the less be allowed for in the creation of the structure to accomplish a set of tasks.

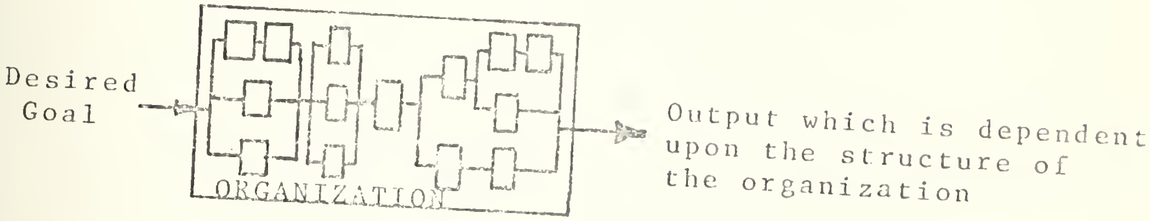
The appropriate structure for a specific task will vary somewhere on a continuum from a closed, bureaucratic organization to an open organization. When multiple tasks are being considered, a mixed structure can be used with coordinating mechanisms as required. Ultimatley, in the case of multiple tasks of a nature that varies over time the optimum structure must also vary over time. The practical result is that some compromise in structure is achieved that will provide the best performance by the organization even though

Figure 6 - Organization Models

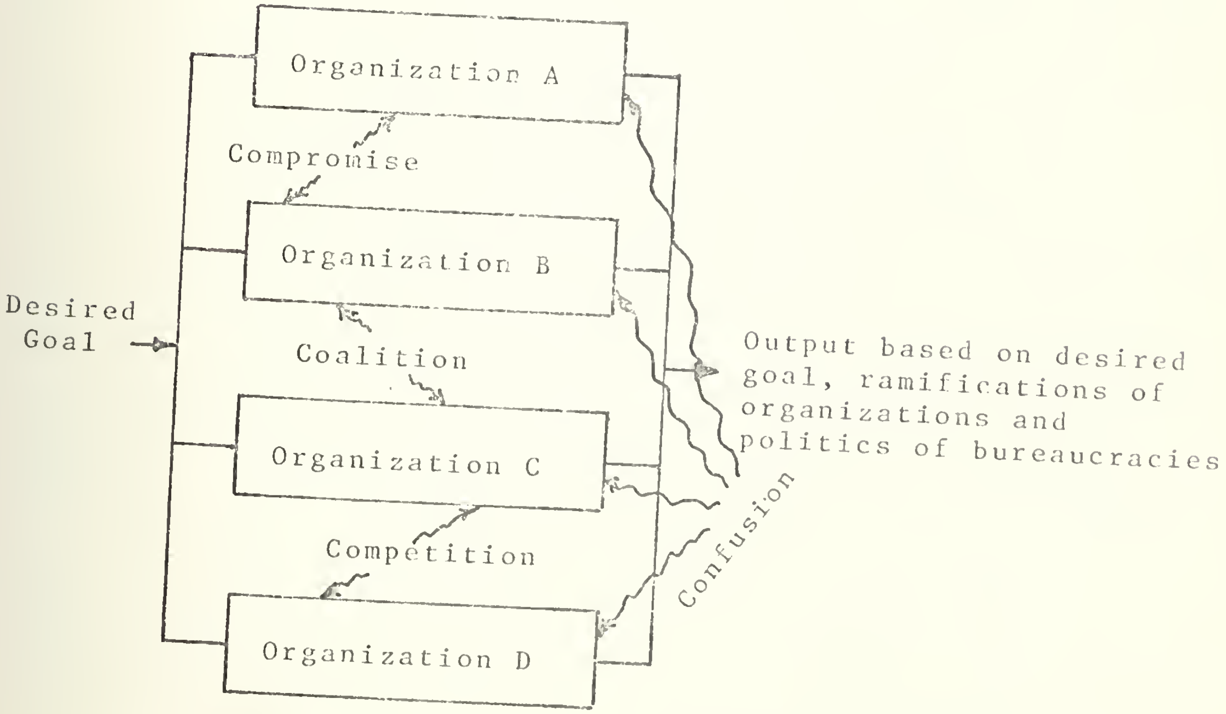
RATIONAL POLICY MODEL


Desired Goal
Organization (acting to carry out desired goal)
Output which can be traced directly to goal

ORGANIZATIONAL PROCESS MODEL


Desired Goal
ORGANIZATION
Output which is dependent upon the structure of the organization

BUREAUCRATIC POLITICS MODEL


Organization A
Compromise
Organization B
Desired Goal
Coalition
Organization C
Competition
Organization D
Output based on desired goal, ramifications of organizations and politics of bureaucracies
Confusion

most favorable performance of individual sub-units on specific tasks may not be achieved.

The structure of the system that creates, develops and constructs weapons systems will determine the conduct of the individual organizations and of the system as a whole. The performance of the system will then be a direct result of its structure and conduct. Conversely, if we can define a "good" performance, then there is a structure of the system that will give that performance on a given task or tasks. Finally, if the task changes or a change in performance is desired, a change in the structure must be made.

F. THE APPLIED VIEW OF SHIP'S ACQUISITION STRUCTURE AND TASKS

In the view of this thesis, there are five major organizations that play a part in the acquisition of a ship: Department of Defense, Industry, the Courts, Congress and the Office of the President. These organizations are divided into numerous smaller organizations which will be described later in the thesis. The organizations and their sub-organizations are connected internally and externally by a vast network of formal and informal mechanisms. Collectively the organizations, the sub-organizations and the connecting mechanisms constitute the structure of the ship's organization process. Figure 7 is a diagram of this basic structure.

The tasks required to go from technical ability and need for a ship through the completion of an actual ship are: Development of systems, Integration of systems, Construction of the ship(s), Control of the Process and Provision of

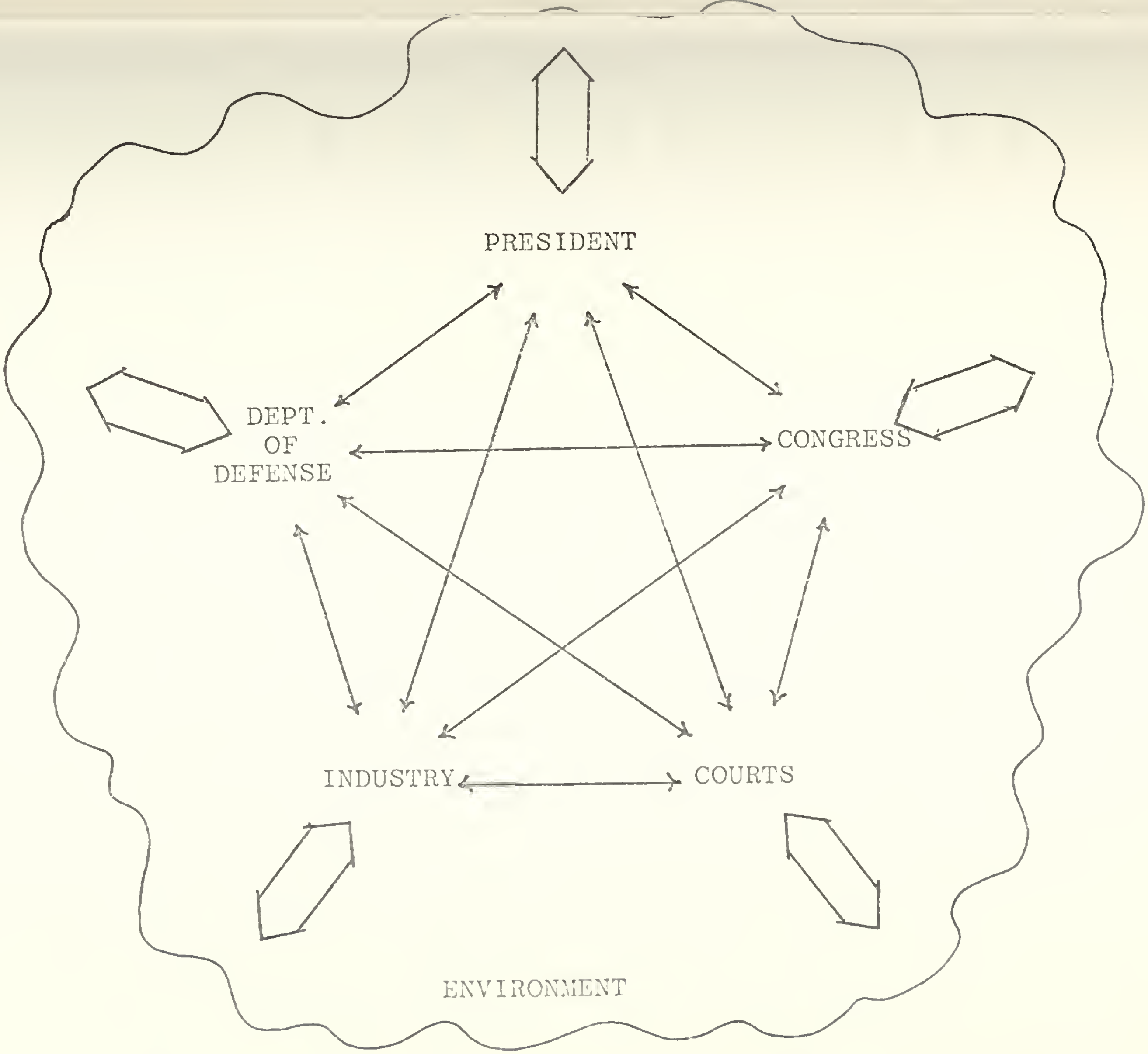

PRESIDENT
DEPT. OF DEFENSE
CONGRESS
INDUSTRY
COURTS
ENVIRONMENT

Figure 7 - Structure of Ship's Acquisition

Resources. As with the organizations, there are numerous subdivisions of the tasks and may innerconnecting mechanisms. The development of systems, the integration of system and the construction of the ship are a flow over a period of time, requiring control and the provision of resources throughout the process. Figure 8 is a diagram of the basic tasks required to acquire a ship. No feedback is shown between the major tasks in the flow from development through integration to construction as these tasks take place over time, but each task is an iterative process containing feedback within the task itself and feedback to the acquisition of other ships and weapons system. Specific descriptions of the structure and tasks applicable to ship acquisition will be found in the following chapters.

The form and size of a structure will determine its conduct with respect to the tasks it is required to perform. If the structure is of appropriate size and form for the tasks it is required to perform, the structure will produce the desired output at maximum efficiency and effectiveness. If the structure is at variance with the tasks, less than optimum performance will result. The tasks being considered are related to the acquisition of ships and their systems, which are not the only tasks required of the components of the structure. As an example, the Naval Sea Systems Command and, at a lower level, the Naval Ships Engineering Center have not only the tasks related to the development and construction of new construction ships, but they have tasks

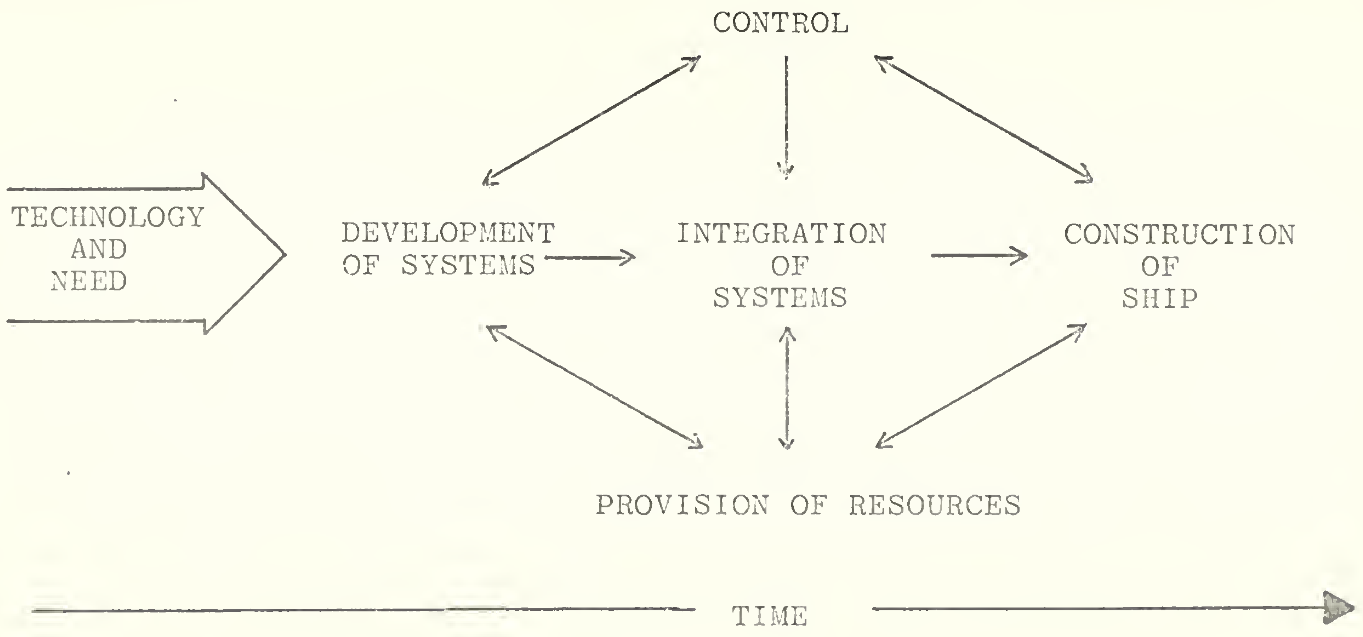

CONTROL
TECHNOLOGY AND NEED
DEVELOPMENT OF SYSTEMS
INTEGRATION OF SYSTEMS
CONSTRUCTION OF SHIP
PROVISION OF RESOURCES
TIME

Figure 8 - Tasks of Ship's Acquisition

relating to continued support of presently operating ships in the fleet. The tasks frequently are similar enough and the resources available are limited enough that the same subunits are used for both new construction and operating ship support. An example of the problems that result from this dual usuage will be presented in Chapter V.

This thesis will consider the structure as it applies to the development and construction of ships. The structure that is applicable to the tasks associated with ship development and construction can easily be different from the structure that is applicable to the other tasks required of the participating organizations. As a result, any restructuring of the system must keep all of the desired outputs in mind so that the changes in structure to improve the ship acquisition process do not act to the detriment of the outputs of the system as a whole.

III. STRUCTURE OF THE NAVY SHIP WEAPONS SYSTEM ACQUISITION PROCESS

A. THE WEAPONS SYSTEM ACQUISITION PROCESS

The major weapons system acquisition process is generally considered to contain five distinct phases. These phases are applicable to systems that are to be installed on a ship but are not generally considered applicable to the ship as a whole. The first phase, referred to as the Research Phase develops the basic technology required for the weapon. No hardware is generally produced during this phase. The next phase, the Exploratory Development Phase, is devoted to producing a specific application of the principles discovered during the Research Phase. The output of this phase is likely to be a breadboard model, proving that the concept works in a laboratory environment. The third step is the Advanced Development Phase, in which it is desired that an operating prototype of the system be manufactured and tested. This workable, handmade version of the system is the goal of this phase of the development. The fourth step is the Engineering Development Phase, which results in an engineering development prototype and finally a production prototype or an initial production model. The final phase is the production phase, in which the actual system is produced and delivered to the fleet. For a ship, these phases are smeared due to the lack of prototypes and the variation in the stage of development of the ship systems.

Three additional processes, with the five mentioned above, make up the full cycle of the system. Operational Test and Evaluation (OT&E) occurs late in the Engineering Development Phase and continues into the early part of the Production Phase. The purpose of the OT&E is to demonstrate system capability and ultimately to prove operating and maintenance tasks developed for the system. Beginning with delivery of the first unit to the fleet, the Operation and Maintenance Phase describes the period during which the system is in actual use by the fleet. Parallel to the actual operation of the system, a Product Improvement Phase is conducted. Feedback from actual operational experience is used to upgrade the system during its entire lifetime.(36:pp. 4-5)

Another common description of the phases of development of a system includes the Conceptual, the Validation, the Full-scale (engineering) Development and the Production Phases. By this grouping, the need for new military capability is formulated, a concept which will provide this capability is established and the technical feasibility of the concept is explored. During the Validation Phase, the preliminary designs and engineering for the weapons system are verified and the initial planning is done for system development. The Full-Scale Development Phase encompasses the completion of the design and detailed engineering. This stage includes the manufacture of a near-production prototype and testing to verify the final design and producability. The Production Phase begins with the negotiation and award

of the production contract, continues through the production acceptance tests and ends when the last system is delivered. (21:pp. 8-10) This view and the proceeding concept of a weapons system acquisition are illustrated in Figure 9.

The first major drawback of these views of weapons system acquisition comes from their simplicity. The logical assumption and the desired process in the eyes of the office of the Secretary of Defense is for these processes to take place in sequence, one at a time. "Concurrency" is a phrase that has been coined to describe beginning production before development has been completed. In the current administration, this is generally considered a "bad" and costly practice. (71:pp. 16-17) Other authors at least recognize the fact that there are no distinct dividers between the phases of weapons procurement. Each phase dribbles into the next as one task never seems quite complete before the commencement of the next. The simplicity of the previous models does not provide a problem to those who are familiar with the process, but for those outside the system, oversimplication can lead to conclusions that would, if carried to their logical ends, result in significant elongation of the procurement process. This would result from the implicit requirement that each stage be completed with all problems solved before proceeding to the next phase. A more realistic view of the process is shown in Figure 10. With the exception of the break that comes between Advanced Development and Engineering Development, there is no clear cut dividing line

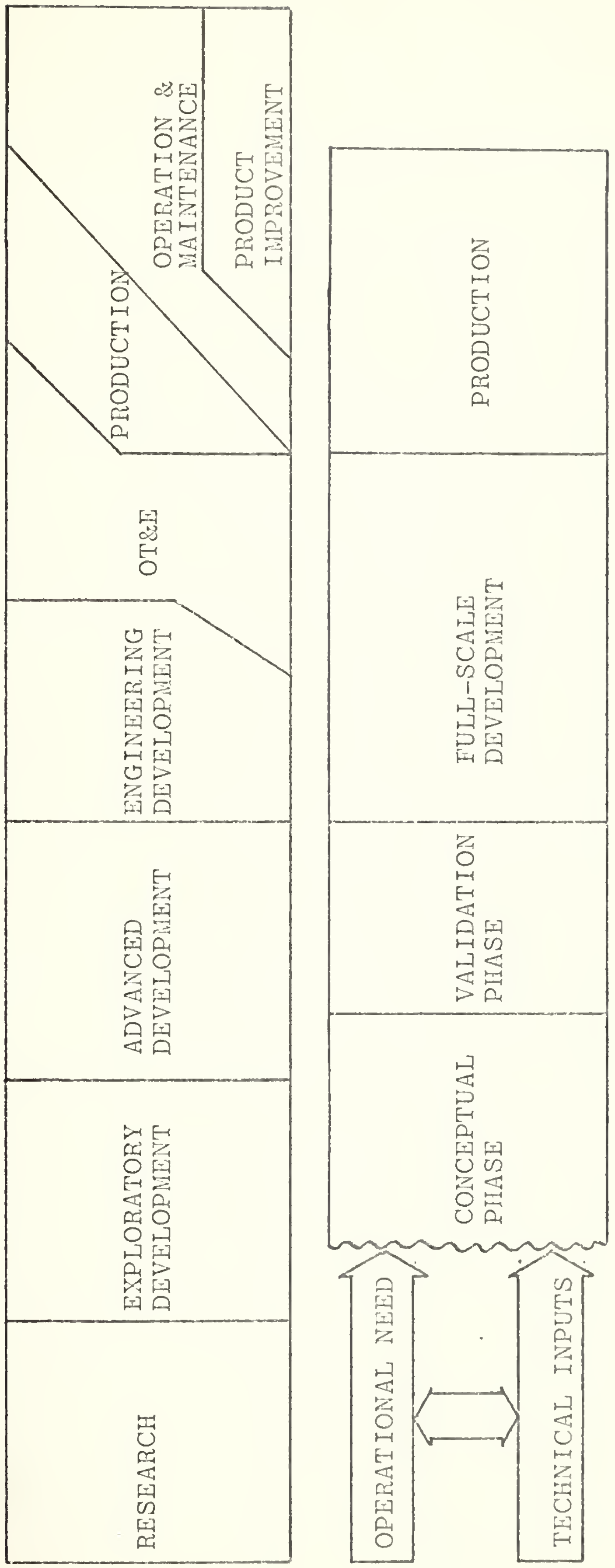

RESEARCH
EXPLORATORY DEVELOPMENT
ADVANCED DEVELOPMENT
ENGINEERING DEVELOPMENT
OT&E
PRODUCTION
OPERATION & MAINTENANCE
PRODUCT IMPROVEMENT
OPERATIONAL NEED
TECHNICAL INPUTS
CONCEPTUAL PHASE
VALIDATION PHASE
FULL-SCALE DEVELOPMENT
PRODUCTION

Figure 9 - Idealized Program Phases

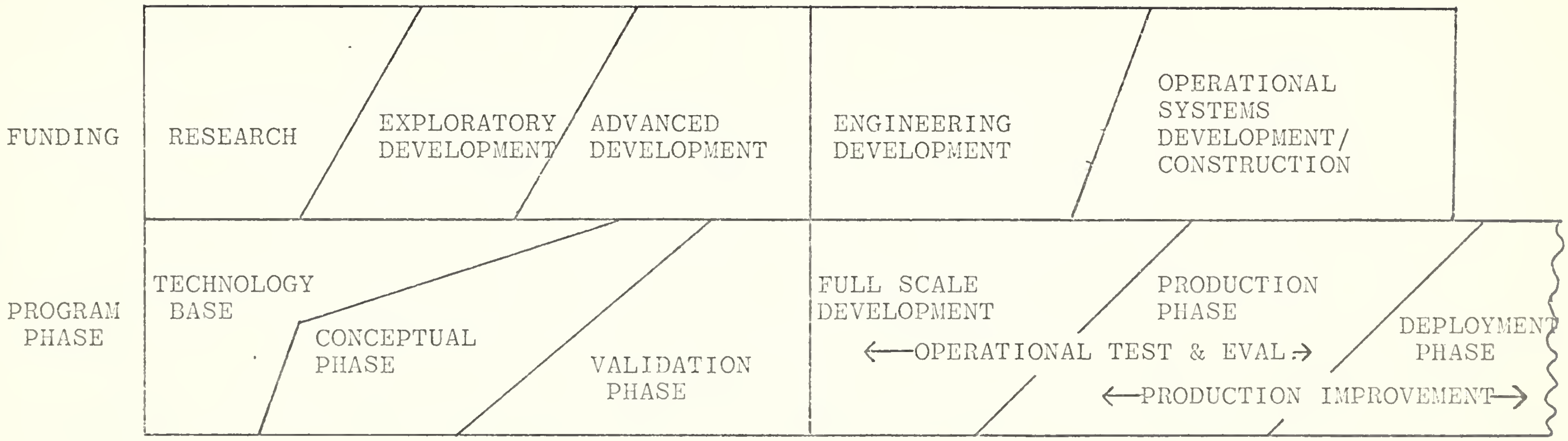

FUNDING
RESEARCH
EXPLORATORY DEVELOPMENT
ADVANCED DEVELOPMENT
ENGINEERING DEVELOPMENT
OPERATIONAL SYSTEMS DEVELOPMENT/ CONSTRUCTION
PROGRAM PHASE
TECHNOLOGY BASE
CONCEPTUAL PHASE
VALIDATION PHASE
FULL SCALE DEVELOPMENT
PRODUCTION PHASE
DEPLOYMENT PHASE
←OPERATIONAL TEST & EVAL.→
←PRODUCTION IMPROVEMENT→

Figure 10 - Integrated Procurement Process

between the phases of the weapon system procurement process. Frequently not all of the questions have been answered about the technology before the conceptual phase is started and may not be answered until well into the evaluation phase. Although the Department of Defense instructions require that all the steps of one phase be completed before proceeding to the next phase, actual practice shows that this is seldom the case.(35:p. 17)

The other significant problem is the application of this simplistic viewpoint to the development and production of a complex set of weapon systems. A ship is such a set of weapon systems. The state of development of the various components of the ship can vary all the way from the use of a mandane, proven hull to the use of a weapon or sensor system that is little more than a glimmer in the eye of the developer. Each of these systems must be integrated to provide a coordinated ship that is ready to meet its mission requirements on the day that it completes outfitting. As a result, although the ship itself is considered a major weapons system under Department of Defense Directive 5000.1, it really is an accumulation or set of systems that can exhibit attributes of any stage of the development process.

B. THE PLAYERS

There are five basic "players" in the weapons system acquisition field. The Department of Defense is both the "buyer" and the "user" of the defense systems. The executive branch is the coordinator of all of the services, such as

defense, public health and currency regulation, provided by the United States government. As such, it also has a significant say in the distribution of the funds available for the various departments operations. The Congress, or legislative branch, is the provider of funds. This is not the extent of its participation, for it also authorizes specific programs and exercises legislative oversight. The contractors are the providers of goods and services for the Department of Defense under our system. Although some goods and services are provided by Naval shipyards, Navy labs, Army arsenals and the like, the large preponderence of weapons system procurement dollars goes to private industry. Navy Laboratories continue to make significant contribution to the state-of-the-art of weapons system advancement. The Naval systems Engineering Center (NAVSEC) has taken over the task of the major portion of the design of the Navy's ships, but still the lions share of the Navy's weapons systems are built by private contractors. Finally, the Courts act as the final arbitrators between the players of the game. They simultaneously decide what was wrong in the players interpretation of the Law and the contracts, and just what the errors were worth in additional payments or denial of payments to contractors.

1. Department of Defense

The proliferation of organization relating to ship acquisition in the Department of Defense alone is overwhelming. The follow set of short sketches provides the reader with an

insight into the complexity of the formal DOD structure as it relates to ship acquisition.

a. Office of the Secretary of Defense

The major individual participants in the weapons acquisition business in the Office of the Secretary of Defense (OSD) are the Director of Defense Research and Engineering (DDR&E), and the Assistant Secretaries of Installation and Logistics, Comptroller and Program Analysis and Evaluation. Groups that carry responsibility within this office (OSD) are the Defense System Acquisition Review Council (DSARC), the Armed Services Board of Contract Appeals (ASBCA), the Armed Services Procurement Regulation (ASPR) Committee, the Weapons System Evaluation Group (WSEG), and the Joint Chiefs of Staff (JCS). Figure 11 is a diagram of the organizational relationship of the Office of the Secretary of Defense.

The Assistant Secretary of Defense (Installation and Logistics), (ASD(I&L)), has the principle responsibility for procurement management, policy and control. He is responsible for the establishment of uniform DOD procurement policies, methods and procedures as well as carrying direct responsibility for weapons systems in production. The Director of Defense Research and Engineering (DDR&E) supervises all research and engineering activities in the Department of Defense. As such, he is responsible for all of the Defense Department major weapons system acquisitions up the decision to go into productions on the system. The Assistant Secretary of Defense (Comptroller)(ASD(C)) does the

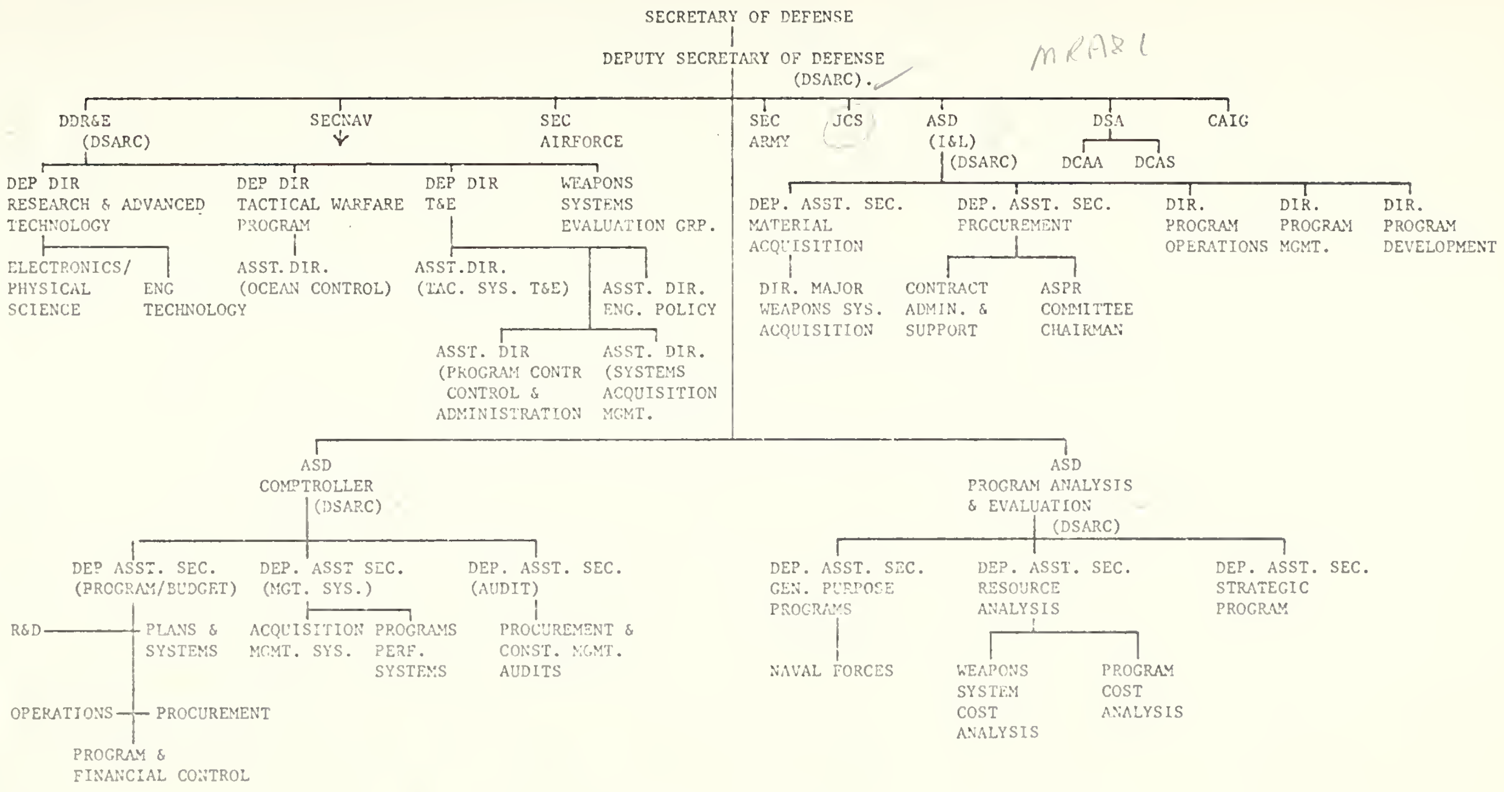

SECRETARY OF DEFENSE
DEPUTY SECRETARY OF DEFENSE (DSARC).
MRA&L
DDR&E (DSARC)
SECNAV
SEC AIRFORCE
SEC ARMY
JCS
ASD (I&L) (DSARC)
DSA
CAIG
DCAA
DCAS
DEP DIR RESEARCH & ADVANCED TECHNOLOGY
DEP DIR TACTICAL WARFARE PROGRAM
DEP DIR T&E
WEAPONS SYSTEMS EVALUATION GRP.
ELECTRONICS/ PHYSICAL SCIENCE
ENG TECHNOLOGY
ASST. DIR. (OCEAN CONTROL)
ASST. DIR. (TAC. SYS. T&E)
ASST. DIR. ENG. POLICY
ASST. DIR (PROGRAM CONTR CONTROL & ADMINISTRATION
ASST. DIR. (SYSTEMS ACQUISITION MGMT.
DEP. ASST. SEC. MATERIAL ACQUISITION
DEP. ASST. SEC. PROCUREMENT
DIR. PROGRAM OPERATIONS
DIR. PROGRAM MGMT.
DIR. PROGRAM DEVELOPMENT
DIR. MAJOR WEAPONS SYS. ACQUISITION
CONTRACT ADMIN. & SUPPORT
ASPR COMMITTEE CHAIRMAN
ASD COMPTROLLER (DSARC)
ASD PROGRAM ANALYSIS & EVALUATION (DSARC)
DEP ASST. SEC. (PROGRAM/BUDGET)
DEP. ASST SEC. (MGT. SYS.)
DEP. ASST. SEC. (AUDIT)
R&D
PLANS & SYSTEMS
OPERATIONS
PROCUREMENT
PROGRAM & FINANCIAL CONTROL
ACQUISITION MGMT. SYS.
PROGRAMS PERF. SYSTEMS
PROCUREMENT & CONST. MGMT. AUDITS
DEP. ASST. SEC. GEN. PURPOSE PROGRAMS
DEP. ASST. SEC. RESOURCE ANALYSIS
DEP. ASST. SEC. STRATEGIC PROGRAM
NAVAL FORCES
WEAPONS SYSTEM COST ANALYSIS
PROGRAM COST ANALYSIS

Figure 11 - Organization of the Secretary of Defense

physical preparation of the Defense Budget and acts as a general watchdog over defense spending. The Assistant Secretary of Defense (Program Analysis and Evaluation) (ASD(PA&E)) is responsible for the evaluation of the individual weapons system programs, both from the standpoint of individual effectiveness and from an integrated forces viewpoint.(9:p. 43)

The Defense System Acquisition Review Council is the group of OSD officials who, in essence, approve the advancement of a major weapons system from one phase of development to the next.

The members of the DSARC are the DDR&E, ASD(I&L), ASD(C) and ASD(PA&E). Other assistant secretaries having an interest in a specific DSARC meeting also participate (e.g. Assistant Secretaries for Telecommunication and Intelligence). "The mission of the DSARC is to serve as an advisory body to the SECDEF on major defense system programs, to provide him with supporting information and recommendations when program decisions are necessary, and to conduct management reviews on such programs at least once during their life cycle."(25:p. m-61) In actual practice, the DSARC reviews the progress of each major program at each major milestone and either permits it to go on to the next phase of its development or holds it up for further work in the existing state. Although they have the authority to recommend cancellation of a program at this stage, they have not normally taken this course of action.

The ASBCA reviews claims against the government by civilian contractors and either specifies the amount due the contractor from the government or finds against the contractor, which generally has the effect of pushing the case into the Court of Claims. The board is established by charter within the Office of the Secretary of Defense, but draws its jurisdiction solely from the inclusion of the "Disputes" clause in procurement contracts.(56:pp. 10, 246)

The codification of rules relating to Department of Defense procurement is the Armed Services Procurement Regulations (ASPR). This set of regulations has uniform applicability to every defense procurement from belt buckles to cruisers. It is under almost constant revision to ensure that it stays abreast of advances in both weapons technology and procurement management. Each service is represented on the ASPR Committee, which reports to ASD(I&L). This committee is responsible for ensuring the ASPR reflects the latest changes in procurement law and philosophy.

Operational analysis and systems evaluations are provided by the Weapons System Evaluation Group. Although the group functions under the direction of DDR&E, they perform studies for the JCS and other elements of the Office of the Secretary of Defense as well. The studies provide a quantified input for long range planning.(30:p. E-2)

Finally, the Joint Chiefs of Staff provide the integrated military input from the individual services. Within the guidance provided by the Secretary of Defense and

the secretaries of their respective services, the service chiefs do the long range planning, prepare the initial budget requests and finally actually procure and use the weapons systems.

Two other agencies of significance to weapons system acquisition report directly to the OSD. The Defense Contract Audit Agency (DCAA) performs all necessary contract audits for DOD. They also provide accounting and financial advisory services regarding contracts and subcontracts to all components of DOD who are responsible for procurement and contract administration. The Defense Supply Agency (DSA) is charged with providing economic logistic support to all portions of DOD. DSA administers all items that are common to more than one service. Their principle involvement with weapons procurement is in their actions as contract administrators. Though they are seldom involved in the administration of a prime contract for a ship, the major portion of all government furnished equipment (GFE) is provided under a contract administered by a Defense Contract Administration Service Office (DCASO), the contract administration arm of DSA.(30:p E-6)

b. Office of the Secretary of the Navy

The components of the Office of the Secretary of the Navy that make a major contribution to the navy's weapons system acquisition process are the Assistant Secretary of Navy (Installation and Logistics)(ASN(I&L)), the Assistant Secretary of Navy (Research and Development)

(ASNR&D)), the Assistant Secretary of Navy (Financial Management)(ASN(FM)), the Assistant Secretary of Navy (Comptroller (ASN(C)), the Chief of Naval Research, the Director of Navy Labs. and the Department of the Navy System Acquisition Review Council (DNSARC). Figure 12 is a diagram of the formal organization of the Office of the Secretary of Navy and of the Chief of Naval Operations.

ASN(I&L) is responsible for the policy, management, and control of production, procurement, supply and distribution of material throughout the Navy. He is the SecNav equivalent of the ASD(I&L).(9:pp. 49-50) ASN(R&D) is responsible for the performance of research, development, engineering, test and evaluation of the Navy's weapon system programs. As such, he is the equivalent of DDR&E within the Office of the Secretary of the Navy.(30:p. E-7) The ASN(C) also has the equivalent responsibility to his counterpart, ASD(C). The major variations in structure of the Office of the Secretary of the Navy from the pattern of OSD are the deletion of an assistant secretary for Program Analysis and Evaluation and the addition of the Chief of Naval Research and the Director of Navy Laboratories. OP 96, the Systems Analysis section of the Office of the Chief of Naval Operations (CNO) performs the program analysis and evaluation for the Secretary with the Office of Program Appraisal acting as the Secretary's review agent. The Chief of Naval Development directs the operations of the Naval Research Laboratories and the Director of Navy Labs is responsible

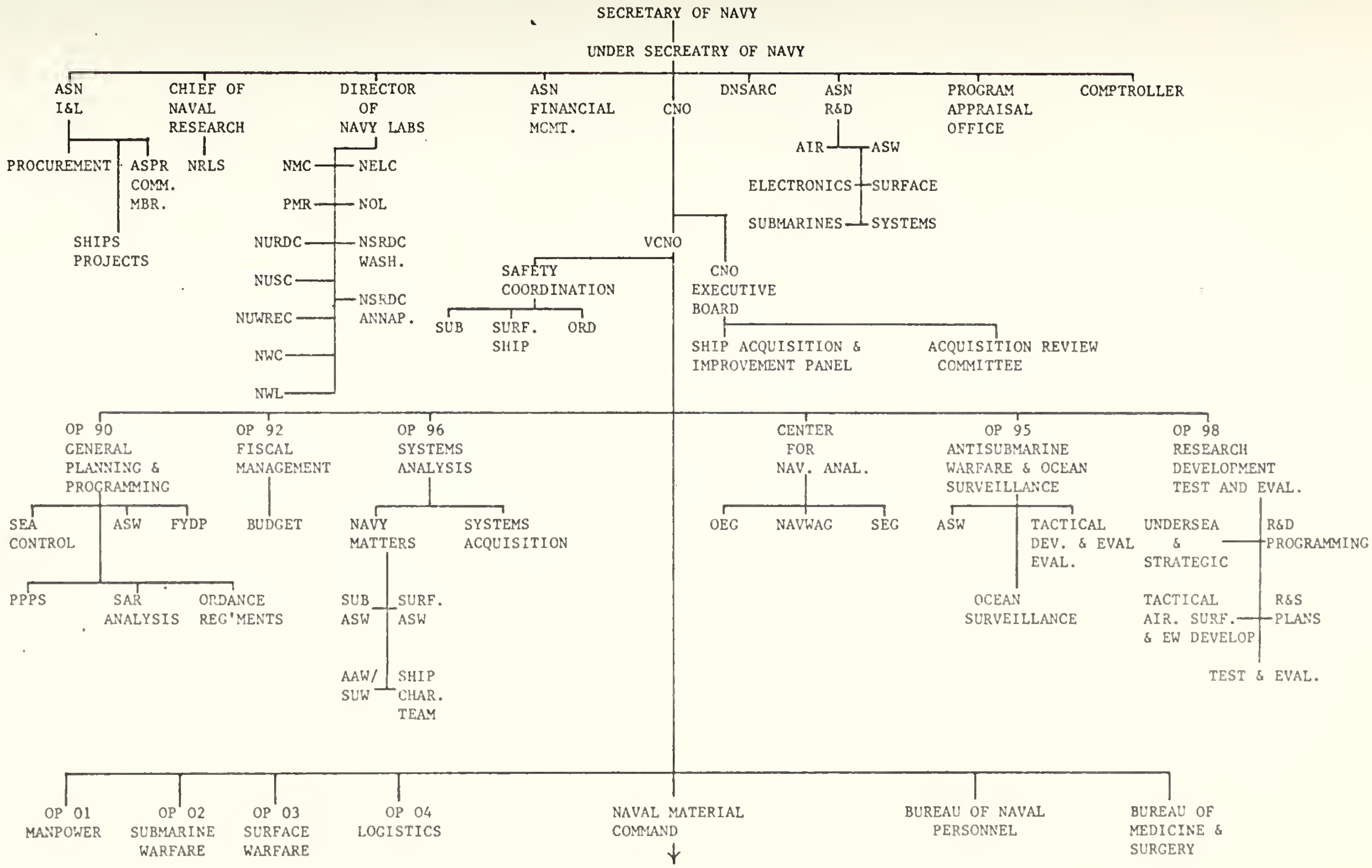

SECRETARY OF NAVY
UNDER SECREATRY OF NAVY
ASN I&L
PROCUREMENT
ASPR COMM. MBR.
SHIPS PROJECTS
CHIEF OF NAVAL RESEARCH
NRLS
DIRECTOR OF NAVY LABS
NMC
NELC
PMR
NOL
NURDC
NSRDC WASH.
NUSC
NSRDC ANNAP.
NUWREC
NWC
NWL
ASN FINANCIAL MGMT.
CNO
VCNO
SAFETY COORDINATION
SUB
SURF. SHIP
ORD
CNO EXECUTIVE BOARD
SHIP ACQUISITION & IMPROVEMENT PANEL
ACQUISITION REVIEW COMMITTEE
DNSARC
ASN R&D
AIR
ASW
ELECTRONICS
SURFACE
SUBMARINES
SYSTEMS
PROGRAM APPRAISAL OFFICE
COMPTROLLER
OP 90 GENERAL PLANNING & PROGRAMMING
SEA CONTROL
ASW
FYDP
PPPS
SAR ANALYSIS
ORDANCE REG'MENTS
OP 92 FISCAL MANAGEMENT
BUDGET
OP 96 SYSTEMS ANALYSIS
NAVY MATTERS
SYSTEMS ACQUISITION
SUB ASW
SURF. ASW
AAW/ SUW
SHIP CHAR. TEAM
CENTER FOR NAV. ANAL.
OEG
NAVWAG
SEG
OP 95 ANTISUBMARINE WARFARE & OCEAN SURVEILLANCE
ASW
TACTICAL DEV. & EVAL EVAL.
OCEAN SURVEILLANCE
OP 98 RESEARCH DEVELOPMENT TEST AND EVAL.
UNDERSEA & STRATEGIC
R&D PROGRAMMING
TACTICAL AIR. SURF. & EW DEVELOP
R&S PLANS
TEST & EVAL.
OP 01 MANPOWER
OP 02 SUBMARINE WARFARE
OP 03 SURFACE WARFARE
OP 04 LOGISTICS
NAVAL MATERIAL COMMAND
BUREAU OF NAVAL PERSONNEL
BUREAU OF MEDICINE & SURGERY

Figure 12 - Organization of the Secretary of Navy and Chief of Naval Operations

for the remainder of the Navy Labs. Both hold dual titles, however. The Director of Navy Labs works for the Chief of Naval Development in his position of Director of Laboratory Programs working for the Deputy Chief of Naval Material (Development).(69:p. 52) Additional ties remain between the personnel of the labs and their former sponsoring bureau. As a for instance, the Weapons Laboratory, Dahlgren personnel still feel that they are working for the section of Naval Sea Systems Command that used to be the Bureau of Ordance.

The DNSARC performs the same function for the Secretary of the Navy that the DSARC does for the Secretary of Defense. The relationship between program size and decision level is shown in Figure 13.

c. Chief of Naval Operations

The Chief of Naval Operations commands the operating forces of the Navy, which include several fleets, seagoing forces, sea frontier forces, Fleet Marine Forces and others. He also commands the Naval Material Command, the Bureau of Naval Personnel and the Bureau of Medicine and Surgery. In meeting these committments he determines the requirements of naval forces and activities for research, development, test, evaluation and procurement of weapons systems for the Navy's needs. He plans and provides for the conduct of development, test, and evaluation of the systems and lastly he obtains funding and progresses them from the earliest stages of development, through production and deployment to the final phase-out of the system.

General Dollar Threshold (millions)	Type of System	Decision Body	Decision Recording Document	Level of Approval
RDT&E greater than \$50 and/or Production greater than \$200 or as directed	DOD Designated	CEB/ARC, DNSARC and	DCP	SECDEF
As directed		CEB/ARC and DNSARC	PM	DSARC Principal
As directed	Dept. of Navy Designated	CEB/ARC and DNSARC	NDCP	SECNAV
RDT&E greater than \$20 and/or production greater than \$50 or as directed		CEB/ARC	NDCP	CNO
As directed	Non-designated		Abbreviated NDCP	DNPP or DRDT&E

Reference (39:p.8)

Dollars in Millions

FIGURE - 13 Navy Systems Acquisition

RDT&E = Research, Development Test & Evaluation

DOD = Department of Defense

CNO = Chief of Naval Operations

CEB = CNO advisory board

ARC = Acquisition Review Committee

DNSARC = Defense System Acquisition Review Committee

DCP = Decision Coordinating Paper

PM = Program Memorandum

NDCP = Navy Decision Coordi Coordinating Paper

SECDEF = Secretary of Defense

SECNAV = Secretary of Navy

DNPP = Director, Navy Program Planning

DRDT&E = Director, RDT&E

The organization under the Chief of Naval Operations relating to ships system procurement can be divided into four basic categories; Line, Staff, Bureaus, and internal staff. The Line organizations relating to ship's acquisition include OP 01 (Manpower), OP 02 (Submarine Warfare), OP 03 (Surface Warfare), and OP 04 (Logistics). The mission of the line Deputies includes the determination of requirements, force levels and major characteristics of applicable ship types, appropriate support ships and weapons systems. This responsibility includes not only the material requirements, but the operational readiness, tactical doctrine and training related requirements as well. These deputies provide the operational requirements which when coordinated with development proposals from the material commands result in the establishment of the specific requirements for weapons systems. This is referred to as the "User-Producer dialogue."(69:pp.E-11-12)

The Staff Directorates applicable to material acquisition are OP 90 (General Planning and Programming), OP 92 (Fiscal Management), OP 95 (Anti-submarine Warfare and Ocean Surveillance), OP 96 (Systems Analysis) and OP 98 (Research, Development, Test and Evaluation). These directorates provide a basic coordinating function across all programs and offices. Within their own specialities, they bring together the requirements and establish the policy for each of the warfare specialities.

"The Bureaus" is a historical designation including the Systems Commands of the Naval Material Command, the Bureau of Naval Personnel and the Bureau of Medicine and Surgery. These commands are the providers of ships, airplanes, electronics, facilities and people (including their health care). As such, they are the "producers" of the user-producer dialogue. Their function is to provide the material and people for use by the operational forces in meeting the requirements of the Navy's mission.

The internal staff includes the Safety Coordination Group, the CNO Executive Board with its Ship Acquisition and Improvement Panel (SAIP) and Acquisition Review Committee (ARC) and the Center for Naval Analysis with its Operations Evaluation Group (OEG), Systems Evaluation Group (SEG) and Naval Warfare Analysis Group (NAVWAG). These groups function to provide advice and information to the Chief of Naval Operations on their areas of specialty. As an example, the SAIP is a special panel of the CEB with cognizance for developing, monitoring and controlling the characteristics of all ships, floating dry docks, landing and service craft.(69:p. E-40)

d. Chief of Naval Material

The principle players in the Office of the Chief of Naval Material (CNM) are the Deputies, the System Commands and the CNM Designated Project Offices. The Deputies applicable to ship acquisition are MAT 01 (Programs and Financial Management), MAT 02 (Procurement and Production),

MAT 03 (Naval Development), MAT 04 (Operations and Logistics) and MAT 06 (Reliability and Maintainability). Each of the Deputies provides staff assistance to the CNM in his area of responsibility. Additionally, MAT 03 directs the laboratories that fall directly under his cognizance, in effect supporting basic research and the engineering development requirements of the system commands. Figure 14 is a diagram of the organization of the Office of the Chief of Naval Material.

Naval Air Systems Command, Naval Electronics System Command, Naval Sea System Command, Naval Supply System. Command and Naval Facilities System Command are, in effect, the "line" organizations of the Office of Naval Material. The Systems Commands are the providers of weapons systems and support to the fleet operating units. Although ship acquisition would seem to involve only the Naval Sea System Command and the Naval Supply System Command, the other system commands provide missiles, electronics, and test and support facilities.

The CNM Designated Project Offices theoretically are temporary offices established by CNM to accomplish a specific task. In fact, although numerous project offices are established when a need is recognized and dissolved when the need no longer exists, several have been around for many years and are meeting a continuing need that is not likely to stop within the foreseeable future. The CNM Project Offices at the time of this writing are PM 1 (Strategic Systems), PM 2 (Trident), PM 4 (Anti-Submarine Warfare

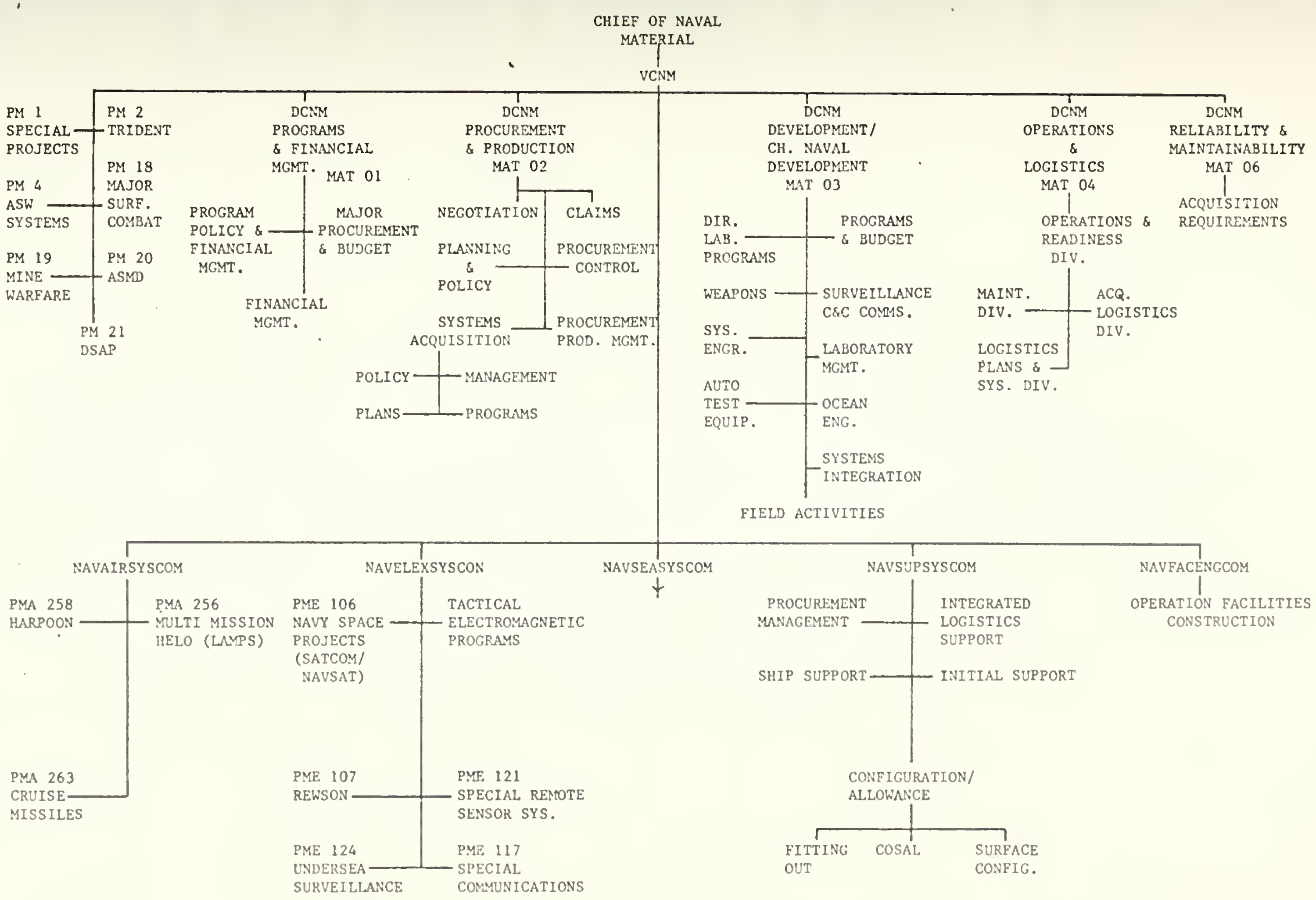

CHIEF OF NAVAL MATERIAL
VCNM
PM 1 SPECIAL PROJECTS
PM 2 TRIDENT
PM 4 ASW SYSTEMS
PM 18 MAJOR SURF. COMBAT
PM 19 MINE WARFARE
PM 20 ASMD
PM 21 DSAP
DCNM PROGRAMS & FINANCIAL MGMT. MAT 01
PROGRAM POLICY & FINANCIAL MGMT.
MAJOR PROCUREMENT & BUDGET
FINANCIAL MGMT.
DCNM PROCUREMENT & PRODUCTION MAT 02
NEGOTIATION
CLAIMS
PLANNING & POLICY
PROCUREMENT CONTROL
SYSTEMS ACQUISITION
PROCUREMENT PROD. MGMT.
POLICY
MANAGEMENT
PLANS
PROGRAMS
DCNM DEVELOPMENT/ CH. NAVAL DEVELOPMENT MAT 03
DIR. LAB. PROGRAMS
PROGRAMS & BUDGET
WEAPONS
SURVEILLANCE C&C COMMS.
SYS. ENGR.
LABORATORY MGMT.
AUTO TEST EQUIP.
OCEAN ENG.
SYSTEMS INTEGRATION
FIELD ACTIVITIES
DCNM OPERATIONS & LOGISTICS MAT 04
OPERATIONS & READINESS DIV.
MAINT. DIV.
ACQ. LOGISTICS DIV.
LOGISTICS PLANS & SYS. DIV.
DCNM RELIABILITY & MAINTAINABILITY MAT 06
ACQUISITION REQUIREMENTS
NAVAIRSYSCOM
PMA 258 HARPOON
PMA 256 MULTI MISSION HELO (LAMPS)
PMA 263 CRUISE MISSILES
NAVELEXSYSCON
PME 106 NAVY SPACE PROJECTS (SATCOM/ NAVSAT)
TACTICAL ELECTROMAGNETIC PROGRAMS
PME 107 REWSON
PME 121 SPECIAL REMOTE SENSOR SYS.
PME 124 UNDERSEA SURVEILLANCE
PME 117 SPECIAL COMMUNICATIONS
NAVSEASYSCOM
NAVSUPSYSCOM
PROCUREMENT MANAGEMENT
INTEGRATED LOGISTICS SUPPORT
SHIP SUPPORT
INITIAL SUPPORT
CONFIGURATION/ ALLOWANCE
FITTING OUT
COSAL
SURFACE CONFIG.
NAVFACENGCOM
OPERATION FACILITIES CONSTRUCTION

Figure 14 - Organization of the Chief of Naval Material

System (ASWS)), PM 18 (Major Surface Combatant Ship), PM 19 (Mine Warfare), PM 20 (Anti-Ship Missile Defense (ASMD)), and PM 21 (Defense Security Assistance Project (DSAP)).(69:p. E-24, 25)

e. Commander Naval Sea Systems Command

The Office of Commander Naval Sea Systems Command contains two types of Directorates, Management Staffs, Boards and Councils, Special Staffs and Designated Projects. The first type of directorate relates to basic ship types, plus one for ammunition. These are SEA 92 (Submarine), SEA 93 (Escort and Cruiser), SEA 94 (Amphibious and Auxiliary Ship), SEA 95 (Aircraft Carrier), and SEA 99 (Ammunition). These directorates are involved not only in the procurement of new systems, but in the monitoring and improving of presently operational systems. The coordinating directorates are SEA 01 (Plans, Programs, and Financial Management/Comptroller), SEA 02 (Contracts), SEA 03 (Research and Technology), SEA 04 (Fleet Support), SEA 05 (Shipbuilding), SEA 06 (Weapons, Systems and Engineering), SEA 07 (Industrial and Facility Management) and SEA 08 (Nuclear Power). These directorates provide services and coordination in their respective areas across all ship types. Figure 15 is a diagram of the organization of the Naval Sea Systems Command.

There are four Boards and Councils applicable to ship system acquisition. The Shipbuilding Council, the Research and Development Council, the Change Control Board and the Budget Review Board all provide advice to Commander Naval Sea Systems Command in their areas of cognizance. The

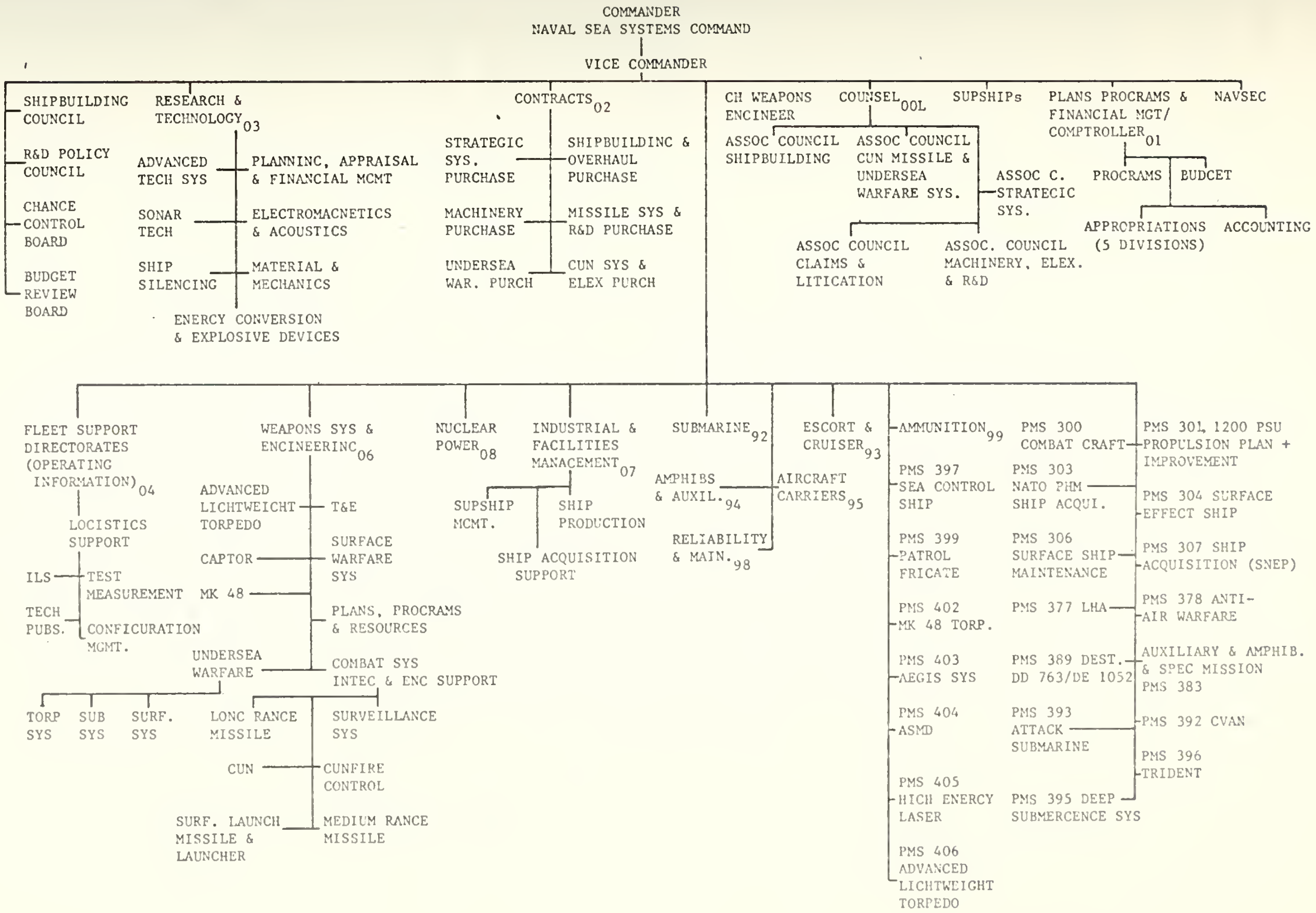

COMMANDER
NAVAL SEA SYSTEMS COMMAND
VICE COMMANDER
SHIPBUILDING COUNCIL
R&D POLICY COUNCIL
CHANGE CONTROL BOARD
BUDGET REVIEW BOARD
RESEARCH & TECHNOLOGY 03
ADVANCED TECH SYS
PLANNING, APPRAISAL & FINANCIAL MGMT
SONAR TECH
ELECTROMAGNETICS & ACOUSTICS
SHIP SILENCING
MATERIAL & MECHANICS
ENERGY CONVERSION & EXPLOSIVE DEVICES
CONTRACTS 02
STRATEGIC SYS. PURCHASE
SHIPBUILDING & OVERHAUL PURCHASE
MACHINERY PURCHASE
MISSILE SYS & R&D PURCHASE
UNDERSEA WAR. PURCH
GUN SYS & ELEX PURCH
CH WEAPONS ENGINEER
COUNSEL 00L
SUPSHIPs
PLANS PROGRAMS & FINANCIAL MGT/ COMPTROLLER 01
NAVSEC
ASSOC COUNCIL SHIPBUILDING
ASSOC COUNCIL GUN MISSILE & UNDERSEA WARFARE SYS.
ASSOC C. STRATEGIC SYS.
ASSOC COUNCIL CLAIMS & LITIGATION
ASSOC. COUNCIL MACHINERY, ELEX. & R&D
PROGRAMS
BUDGET
APPROPRIATIONS (5 DIVISIONS)
ACCOUNTING
FLEET SUPPORT DIRECTORATES (OPERATING INFORMATION) 04
LOGISTICS SUPPORT
ILS
TEST MEASUREMENT
TECH PUBS.
CONFIGURATION MGMT.
WEAPONS SYS & ENGINEERING 06
ADVANCED LIGHTWEIGHT TORPEDO
T&E
CAPTOR
SURFACE WARFARE SYS
MK 48
PLANS, PROGRAMS & RESOURCES
UNDERSEA WARFARE
COMBAT SYS INTEG & ENG SUPPORT
TORP SYS
SUB SYS
SURF. SYS
LONG RANGE MISSILE
SURVEILLANCE SYS
GUN
GUNFIRE CONTROL
SURF. LAUNCH MISSILE & LAUNCHER
MEDIUM RANGE MISSILE
NUCLEAR POWER 08
INDUSTRIAL & FACILITIES MANAGEMENT 07
SUPSHIP MGMT.
SHIP PRODUCTION
SHIP ACQUISITION SUPPORT
SUBMARINE 92
AMPHIBS & AUXIL. 94
RELIABILITY & MAIN. 98
ESCORT & CRUISER 93
AIRCRAFT CARRIERS 95
AMMUNITION 99
PMS 397 SEA CONTROL SHIP
PMS 399 PATROL FRIGATE
PMS 402 MK 48 TORP.
PMS 403 AEGIS SYS
PMS 404 ASMD
PMS 405 HIGH ENERGY LASER
PMS 406 ADVANCED LIGHTWEIGHT TORPEDO
PMS 300 COMBAT CRAFT
PMS 303 NATO PHM SHIP ACQUI.
PMS 306 SURFACE SHIP MAINTENANCE
PMS 377 LHA
PMS 389 DEST. DD 763/DE 1052
PMS 393 ATTACK SUBMARINE
PMS 395 DEEP SUBMERGENCE SYS
PMS 301, 1200 PSU PROPULSION PLAN + IMPROVEMENT
PMS 304 SURFACE EFFECT SHIP
PMS 307 SHIP ACQUISITION (SNEP)
PMS 378 ANTI-AIR WARFARE
AUXILIARY & AMPHIB. & SPEC MISSION PMS 383
PMS 392 CVAN
PMS 396 TRIDENT

Figure 15 - Organization of Commander - Naval Sea System Command

Special Staffs include such offices as SEA OOD (Public Affairs and Congressional Liason), SEA OOL (Counsel) and SEA OOP (Patent Counsel).

The designated projects are in charge of the program for a specific ship or weapons type. Within NAVSEA, they are responsible for all facets of the weapons system acquisition from the earliest conceptual studies, through development and construction, and into fleet operation and support. There are two additional projects relating to areas of interest on the part of COMNAVSEASYSCOM; the 1200psi boiler system project and the advanced logistic support project.

The field activities of the Naval Sea Systems Command include the Naval Ships Engineering Center, which provides technical assistance in ship design and weapons system integration, the Supervisors of Shipbuilding, which oversee the construction of ships at private shipyards, and Naval Shipyards. Naval Shipyards are presently used only for repair and conversion.(91:p. 59) Of these, at least three have the capability for new construction of ships (including submarines).

2. The Executive Branch

Based on Article 2, Section 2, of the Constitution of the United States, the President is the Commander in Chief of the Armed Forces. Hence the Department of Defense is a part of the Executive Branch as are the Departments of State, Treasury, Justice, Post Office, Interior, Transportation, Argiculture, Commerce, Labor, Health, Education and Welfare

and Housing and Urban Development. For the purpose of the study of Navy ships acquisition, the major interest in the other departments pertains to their competition for a share of the federal budget.

Departmental budgets can be viewed as existing somewhere on a continuum from a portion of the macroeconomic allocation of the nations funds to the satisfaction of departmental needs. The Defense Budget can thus be viewed at one pole as a portion of a national budget which is set by the actions of Congress to achieve a desired relationship between government revenues and expenditures. This macroeconomic view of government fiscal policy would argue that the economic health of the nation is a function of the relationship between total government expenditures and total revenues, both as related to some measure of the total output in goods and services of the nation. This view results in the conclusion that the Executive Departments compete for a slice of the federal budget in some giant zero-sum game. To achieve an increase in the appropriation of one department under this system means a dollar for dollar decrease in the appropriations to another department. This approach ignores any real evaluation of the utility of the individual programs, hence is only one end of the scale of means of considering the budget.

At the other pole, the view is that the Congress of the United States, based on recommendations by the President, decides on the goods and services it desires from each of the

executive departments. Money is then alloted to pay for these goods and services without respect for the size of the budget of the other departments. Line item budgeting with separate appropriations for each department leans toward this view of the federal budget. This view represents the other end of the scale as it does not consider the effect of the budget as a whole. In actual practice, all budgeting will fall somewhere between these two extremes.

In the view of this author, Public Law 93-344, the Congressional Budget and Impoundment Control Act of 1974, putting the total budget under a self imposed Congressional restraint, has had the tendency to strengthen the view of a departments budget as a piece of the total federal budget pie. This strengthens the view of the other departments as competitors for federal spending and further strengthens the position of the various coordinating agencies (Congressional Budget Office, Office of Management and Budget, Appropriations Committees, etc.).

The other function of the President in relation to the Department of Defense is in guidance and management. With his assistants in the Executive Office of the President and the Cabinet, he sets the policies to be followed in the procurement of weapons systems, the size and structure of the armed forces and the makeup of the budget requests. In this task, he is aided by the Office of Management and Budget, the Council of Economic Advisors, the National Security Council, the Office of Emergency Preparedness, the Office of

Science and Technology, the Cabinet and the National Council on Marine Resources and Engineering Development.(69:p. vi) The other significant input to the President is the White House staff. These close advisors, along with the Cabinet, form a major portion of the input on any given policy question. (14:pp. 74-81)

3. The Legislative Branch

Article 1, Section 8 of the U.S. Constitution says "The Congress shall have power to .... provide for the common defense and general walfare of the United States," "raise and support armies, but no appropriation of money to that use shall be for a longer term than two years" and "provide and maintain a navy." It also gives Congress the power "to make rules for the government and regulation of the land and naval forces." Based on these sections of the Constitution, the Congress not only provides the appropriations for the Department of Defense, but specifically dictates how this money shall be used.

a. Congressional Committees

There are four committees in each house of Congress that relate to the weapons system acquisition process. The recently formed Budget Committees, subject to the approval of the Congress as a whole, establish a ceiling on the funds to be budgeted for each government function. This concurrent resolution is based on a budget from the President and modified as the House and Senate see fit. As a concurrent resolution, it forms a self imposed limit and does not require the approval of the President.

The Armed Services Committees create the bills that authorize specific line items for each federal agency. Without authorization, the Navy may not proceed with a program, regardless of financing. The Appropriation Committees create the bills that provide the funding for all government operations, including weapons system acquisitions. Hence to become a viable program, a weapons system must appear in both the authorization and appropriation bills and the total national defense expenditure must be within the quantity allowed by the concurrent budget resolution for the specific fiscal year.

The other committee in each house that is involved in weapons system procurement is the Committee on Government Operations. These committees are basically the overseers of the Executive Branch of the government. They have jurisdiction to inquire into the operations of all executive departments, and have become "large-scale" investigatory agencies. Although they are not the only recipient of Government Accounting Office (GAO) Reports, they are the principle user of GAO's services.(45:pp. 152, 292)

b. Congressional Budget Office

The Congressional Budget Office (CBO) is charged with analyzing the current services budget and the president's budget and drafting each submittal of the budget resolution. They are additionally charged with analyzing the fiscal impact of all reported legislation and conducting long term studies for the Committees of Budget, Appropriations, Ways

and Means, and Finance. The Budget Office is "authorized to secure information, data, estimates, and statistics directly from the various departments, agencies, and establishments of the executive branch of Government and the regulatory agencies and commissions of the Government."(22: Title II)

c. General Accounting Office

The General Accounting Office (GAO) describes itself today as: "... a nonpolitical, nonpartican agency in the legislative branch of the Government created by Congress to act in its behalf in examining the manner in which Government agencies discharge their financial responsibilities with regard to public funds appropriated or otherwise made available to them by the Congress and to make recommendations looking to greater economy and efficiency in public expenditures."(37:p. 1)

GAO is empowered to audit and settle the accounts of executive officers, including the making of legal interpretations incident to these audits. The determinations of the Comptroller General, who is the head of GAO, are final and conclusive upon the Executive branch.(45:p. 139) The other major function of GAO is to conduct investigations at the behest of Congressional Committees and individual members.(45:p. 149)

4. The Judicial Branch

In relation to weapons system procurement the courts provide the basic function of settling claims by contractors against the government and by the government against

contractors. In producing these decisions, the courts in effect interpret the law in relation to the contract. They also, on occasion, settle differences between branches of the government.

In the Tucker Act (28 U.S.C. 1491), the Government consented to be sued by contractors in Federal court. This can only be done after all administrative remedies have been exhausted, which is to say after the Armed Services Board of Contract Appeals (ASBCA) has rendered a decision. The contractor may take his suit to the United States Court of Claims or (if less than $10,000. is involved) to the Federal District Court. Appeal to the Supreme Court is then available as the final judicial remedy.(56:p. 254)

5. Contractors

The most obvious contractors in ship acquisition are the shipyards. The major private shipyards in the United Sates are listed in Table I. All of these shipyards, with the exception of Todd, are subsidiaries of large corporations. (91:p. 31) Based on Fiscal Year 1974 contract awards, however, only Bath Iron Works, Electric Boat, Litton, and Newport News have major Navy ship construction in progress. Marinette Marine Co. of Wisconsin and Bethlehem Steel Co. both have minor shipbuilding contracts in the $10 million to $20 million range.(65:pp. 5-17) The U.S. Navy presently has eight shipyards in operation. All of these shipyards are presently being used only for conversion, repair and overhaul of Navy ships and have not done any new construction work since 1967.

TABLE I

Major Private U.S. Shipyards

Owners(s)	Yard(s)
Congolium Inc.	Bath Iron Works
Bethlehem Steel Corp.	Sparrows Point San Francisco
General Dynamics Corp.	Groton (Electric Boat)
Kaiser Industries Inc. Morrison-Knudson Co., Inc.	National Steel
Litton Industries, Inc.	Ingall's Nuclear S.B. Div. Litton Ship Systems Div.
Lockheed Aircraft Corp.	Seattle
Tenneco, Inc.	Newport News S.B. & D.D.
Ogden Corp.	Avondale
Sun Oil Company	Sun Shipbuilding
Todd Shipyards Corp.	San Pedro
	Seattle

Of these yards, only Philadelphia, Mare Island, and Puget Sound are considered capable of new construction of major ships, hence competition for the private shipyards.(91:p. 59)

The shipbuilder's contribution to the construction of a ship, however, is normally limited to completing the detailed design, construction of the hull and some of the systems, and integration of the ship's systems. The present practice is for earlier phases of the design to come from NAVSEC. The previous practice, with the exception of the era of Secretary of Defense McNamara was for BUSHIPS or a design contractor, such as Gibbs and Cox, to provide the earlier phases of design. Most of the ship's equipment is purchased from contractors specializing in the specific equipment type. This equipment is provided either by the prime contractor for the ship by use of a subcontract or by the government through separate contracts with the equipment supplier. The amount of government furnished equipment (GFE) in relation to the amount of contractor furnished equipment (CFE) varies from contract to contract. The use of more GFE enhances standardization, government control of the design, and the ability to achieve economies of scale by the purchase of the same equipment for several ship types. An additional advantage is that profit is payed only to the equipment producer, not the producer and the prime contractor. The major disadvantage is late arrival of equipment or delivery of equipment not meeting the specifications. These are valid reasons for claims by the prime contractor and/or schedule slippage and inadequate ship performance.

Table II provides an indication of the complexity of contractor contributions to ship system acquisition. The contracts shown are all prime contracts, representing either ships or GFE for installation on ships (and submarines). Literally hundreds of other contractors, such as Worthington Pump Corp., Marrotta Valve Corp., and Tektronix Corp. provide equipment on a subcontract basis to the prime contractors for installation in the ship.

6. Other Groups Influencing the Ships Acquisition Process

A list of groups having a second tier influence on the ships acquisition process would cover many pages without even attempting to describe the relationships involved. Every group that influences the major players is in effect a player in Navy Ship system acquisition. Some of the significant external forces are;

a. Financial Institutions

Although interest is not an allowable expense in weapons system acquisition, the contractors frequently must obtain external financing to have sufficient capital to cover the expenses of producing a system.(9:p. 130) As a result, agencies that effect the money market, such as the Securities and Exchange Commission and the Federal Reserve Board, as well as the general state of the money market itself, all effect the cost and availability of financing to the contractor.

b. Labor Related Factions

Shipbuilding is a labor intensive process, with 40% to 65% of costs going into labor and overhead.(91:p. 47)

TABLE II

Major Ship System Contractors - Fiscal Year 1974

Contractor	Place of Performance	Total Contracts (million $)
Ships		
Bath Iron Works	Maine	92.5
General Dynamics	Connecticut	1,169.9
Litton Systems, Inc.	Mississippi	640.0
Newport News Shipbuilding and Drydock	Virginia	154.0
Marinette Marine	Wisconsin	11.4
Bethleham Steel Co.	Maryland	17.0
Propulsion/Machinery		
General Electric	New York	151.7
Westinghouse	Pennsylvania	193.0
United States Atomic	D.C.	163.6
Boland Machine Mfg.	Louisiana	22.4
De Laval Turbine, Inc.	New Jersey	13.7
United Aircraft	Connecticut	16.9
Electronics		
Raytheon	California	26.1
Hughes	California	22.1
ITT	California	17.1
North American Rockwell	California	20.6
Sperry Rand	New York	71.0
Western Electric	North Carolina	11.5
General Electric	Massachusetts	25.0
IBM	New York	13.0

Table II (continued)

Contractor	Place of Performance	Total Contracts (million $)
Weapons Systems		
Gould	Ohio	83.8
Lockheed Aircraft	California	17.0
Lockheed Missiles & Space	California	368.8
Raytheon	Massachusetts	96.2
General Dynamics	California	57.6
General Electric	Massachusetts	59.1
Boeing	Washington	26.4
Lockheed Electronics	New Jersey	19.0
RCA	New Jersey	22.4
Engineering/Management		
Raytheon	Massachusetts	10.7
Automation Industries	Maryland	20.6
Draper Charles Stark Laboratories	Massachusetts	27.0
Lockheed Aircraft	California	40.6
Rohr Industries	California	12.4
Textron	Louisiana	13.5
Johns Hopkins U.	Maryland	38.9
IBM	Virginia	11.6
Litton Systems, Inc.	Mississippi	

NOTE: Some of the above total contract values include changes to existing contracts.

The labor intensity in supporting corporations varies from almost 100% in the field of Design, Engineering and Management down to the low levels achieved by some of the basic material suppliers (such as piping suppliers). This significant contribution of labor to the cost of a ship means that two types of institutions can play a major role in determining the cost of a ship and its systems. The first is the market using the skills found in the Naval ship system industry. The labor skills used in ship construction itself are common to the construction industry. Combat system and communication system workers are common to the aerospace and communications equipment suppliers. Propulsion and machinery suppliers use general machining skill which can be used in any heavy machinery manufacturing. Hence, the price of the labor input to an integrated ship system is highly dependent on the state of the market in the construction, aerospace, communication, and heavy equipment industries to name but a few of the competitors in the labor market.

The second group that plays a significant role in setting the price of the labor input to Navy ships are the unions. The strength of the unions' control over the price of labor varies significantly from corporation to corporation as well as from union to union in dealing with a specific corporation. In the shipyards themselves, the principle unions representing the labor force are the Industrial Union of Marine and Shipbuilding Workers of America, The International Association of Machinists, The International

Brotherhood of Boilermakers, Iron Shipbuilders, Blacksmiths, Forgers and Helpers, and the International Brotherhood of Electrical Workers.(91:p. 51) Labor union inputs are not limited to direct negotiation with the contractors. Organized labor maintains a strong lobby organization in Washington which exerts a direct influence on government procurement. (71:p. 187)

c. Material Related Factions

Most of the material used in Naval Ship construction either has a civilian use or is produced by corporations. capable of producing similar equipment or material for the civilian market. As a result, there is direct competition to obtain material for use in ship construction. Examples of this are the difficulty experienced early in the "Space Race" of the 1960's in getting high tolerance electronic components. The lead time from ordering a turbine until its delivery has been significantly effected by activity in both the power production construction industry and the civilian tanker construction. Thus the activity in competing markets is going to effect both the price of the material and the schedule of its deliver --- which in turn effects the price of the ship as a whole and its schedule.

d. State and Local Government

State and local governments effect the local tax structure in an attempt to bring industry into the area and/or derive revenue from that industry and the people who work in it. Local laws and political conditions can effect the

ease with which a contractor can attract workers. A significant, though somewhat unusual example of the ability of a state to influence the industry was the State of Mississippi's assistance to Litton Industries in the construction of Litton's west bank facility in Pascagoula, Mississippi. Without the state's assistance, the facility would probably never have been built.

e. Citizens Groups

In the last two decades there has been a significant rise in the number, activities and influence of citizen groups. Their interests vary from environmental considerations to safety, from strengthening our armed forces to pacifism. The effect of these groups is related to their political strength and lobbying ability. They can increase or decrease the national budget and vary the Department of Defense's share of this budget in direct proportion to their ability to influence Congress.

f. Professional, Trade and Industrial Organizations

Various people from within the formal structures of the weapons acquisition structure form organizations based on their mutual interest. Examples of this type of group are Shipbuilders Council of America, the American Society of Naval Engineers and the National Contract Management Association. These associations provide for the flow of new ideas between separate formal organizations through the use of meeting, journels, etc., thereby increasing the state-of-the-art of the system as a whole. This also serves to encourage

the increase of professionalism amongst the individual members of the organization through the sponsership of standards, provision of education for members and general support of professional ethics.

C. COORDINATING AND DIRECTING MECHANISMS

Among the players of the weapons acquisition process, communication exists to provide direction, response and information. The major formal coordinating and directing mechanisms are the Acts of Congress, Court and Administrative Decisions, Presidential and Department of Defense Directives, procurement contracts and other major vehicles.

1. Acts of Congress

There are two basic classes of Congressional Acts that govern the Navy's weapons system acquisition process. Budget, Authorizing and Appropriations acts provide funding and permission to continue a specific program on a year by year basis. Other acts of Congress serve the purpose of governing the actions of the participant in the weapons acquistion process. These can be used to foster some social program or to correct some perceived inadequacy in the mechanics of the process itself.

a. Funding and Authorization Acts

In order to become a viable funded, a program must be authorized by Congressional legislation and included in the appropriation for the Department of Defense. The President annually submits a budget to the Congress containing requests for funding of specific activities. Based on

this budget, authorizing and appropriation bills are initiated by the applicable subcommittee of the Armed Services Committees Appropriation Committee. Most of the work of drafting the bill is done at the subcommittee level. It is then passed by the committee and finally by the Congress as a whole. When this is passed and signed by the President, the Treasury is authorized to fund the applicable department for the purpose specified in the Appropriations Bill. The Annual Budget Resolution relates to specific functions of the Government, providing a budgeted total for that function. This is a self imposed ceiling and does not require Presidential approval, but is designed to act as a cap on the total appropriations of the annual Appropriations Bill.

b. Governing Acts

The principal statue governing defense procurement is the Armed Services Procurement Act of 1947. This act brought together a century of diverse statutes affecting defense procurement, swept away many archaic, conflicting and unnecessary laws and injected a greater flexibility in procurement. Appropriate safeguards to prevent abuse, assure the Government fair and reasonable prices and afford all suppliers the opportunity to compete for, and share in, defense business were included. The act reaffirmed formal advertising and competitive bidding as the preferred methods of procurement, but specified 17 circumstances where exceptions to this general policy could be made.(9:p. 82) Numerous other laws, applicable to labor standards, negotiation and

renegotiation and other areas directly applicable to defense procurement, effect the weapons system acquisition process. A list of some of the more significant of these statutes is provided in Table III.

2. Decisions

The decisions of the courts and various administrative agencies have the effect of clarifying and interpreting the laws as they appear in the statutes. A second function is the actual finding of the amount of money due either the contractor or the government. The first step in the process is for the Contracting Officer to make a decision on the specific point of the contract. If the contractor does not agree, he in effect appeals the decision to the Armed Services Board of Contract Appeals (ASBCA), the Federal District Court, the Court of Claims or the Comptroller General.(56:p. 347)

a. Comptroller General

The Budget and Accounting Act of 1921 gave the Comptroller General the ability to provide for the payment of accounts or claims and the power to audit appropriated funds accounts. Since almost all procurement involves appropriated funds, the Comptroller General's authority extends to nearly all areas of procurement law. His more important decisions are published periodically in a set of books entitled "Decisions of the Comptroller General." (56:p. 10)

b. Attorney General

The Attorney General of the United States renders opinions interpreting statutes governing procurement matters.

TABLE III

MAJOR STATUTES RELATING TO WEAPONS SYSTEM ACQUISITION

Statute	Subject
Armed Services Procurement Act of 1947	General Procurement Policy
Defense Production Act of 1950	Authority to establish priorities for defense material
Tucker Act	Allows suit against the U.S. Government
Public Law 85-804	Allows relief of contractors under extraordinary conditions
Assignment of Claims Act of 1940	Allows claims against the government to be assigned to financial institutions
Buy American Act	Requires use of United States mined and produced material in government contracts
Small Business Act of 1958	Provides for Small Business Administration and small business set asides
Anti-Deficiency Act	Prevents expenditures or obligation in excess of appropriation
Contract Work Hours and Safety Standard Act	Specifies 8-hour day and 40 hour week and certain health and safety standards
Davis-Bacon Act	Minimum wages for contraction workers
Walsh-Healey Public Contracts Act	Minimum wages, work day and minimum age for manufacturing workers
Copeland ("Anti-Kickback') Act	Prevents rebates to contractors or sub-contractors
Civil Rights Act of 1965	Prevents discrimination based on race, color, religion, sex or national origin (subsequently extended to include age)
Truth in Negotiation Act	Requires submission and certification of information by contractor before negotiation of contracts over $100,000
Renegotiation Acts	Provides for review and renegotiation of excessive profits
Budget and Accounting Act of 1921	Establishes the Office of Management of the Budget and General Accounting Office
Congressional Budget and Impoundment Control Act	Establishes current budgetary procedures and impoundment and re-programming controls
Vinson-Trammel Act	Limits aircraft and ship construction profits.

References: (56:pp. 359-478 and 9:pp. 75-78)

These decisions are published in a series of bound volumes entitled "Opinions of Attorneys General," published from 1852 to date and containing opinions from 1791.(56:p. 10)

c. Armed Services Board of Contract Appeals

The decisions of the Armed Services Board of Contract Appeals (ASBCA) are the first (and frequently the final) step in ajudication of a dispute of a question of fact arising under a contract's "Dispute" clause.(56:p. 247)

d. The Courts

The decisions of the courts form the final interpretation of the law and settlement of disputes between contractors and the government. The decisions of all major state and federal courts are published in bound form in one of several reporting series. An example is the G.L. Christian and Associates v. United States Decision, 312 F 2d 418, which stated that even though the required termination clause is missing from a contract, the government has the right of termination of contract for convenience "by operation of the law."(56:p. 269)

3. Presidential Directives

Annually the President issues Foreign Policy Guidance which is the basis for the entire planning, programming and budgeting cycle of the Department of Defense. Additionally, from time to time the President issues directives to the Department of Defense relating either to the weapons systems procurement process, specific programs or mix and size of the armed forces.

4. Department of Defense Directives

Each level in the chain of command from the Secretary of Defense to the lowest supervisory level issues directives relating to the policies it feels should be carried out and specific instructions on the mechanics with which it desires these policies to be carried out. These directives plus memorandums and letters form the direction of the lower echelons by the higher echelons within DOD. Appendix B is a list of directives of the Chief of Naval Ships Systems Command or higher level that are applicable to the acquisition of an escort type ship. This does not include the myriad of instructions that are issued by such organizations as the Supervisors of Shipbuilding, Commander Operation Test and Evaluation Force, Bureau of Naval Personnel, etc.

5. Planning, Programming, and Budgeting System (PPBS) Related Documents

As described in Section D below, there are numerous documents associated with the budget process. Specific descriptions of these documents are provided in Appendix C. They are basically used in an iterative process to assure that each level in the budget chain has the opportunity to make an input and that all of the reasonable alternatives are explored.

6. System Approval Related Documents

Like the budget process, numerous documents are used in the sequence of approval of a weapons system from the earliest conceptual considerations through the actual production of the ship. The documents applicable to this process

are listed in Appendix D. The process itself and the interrelationship of the various documents are described in Section D below.

7. *Selected Acquisition Reports*

Each major defense system acquisition program submits a quarterly Selected Acquisition Report in accordance with DOD INST 7000.3, *Selected Acquisition Report (SAR)*. The implementing instruction in the Navy is SECNAVINST 7700.5B of the same title. This report is used to provide the financial and technical status of the major weapons system acquisition programs to the Office of the Secretary of Defense, the General Accounting Office and Congress.

8. *General Accounting Office Reports*

Based on the Budget and Accounting Act of 1921, the General Accounting Office (GAO) has the authority to investigate any govermental agency using appropriated funds. These investigations are conducted at the request of Committees or specific members of Congress. Appendix E is a list of recent GAO reports applicable to major weapons system acquisition. These reports form the basis for changes in the law and DOD directives.

9. *Contracts*

A contract is a legal agreement between two parties describing an obligation on the part of one party to provide goods and services to the second party in return for a consideration. To be valid and enforceable, a contract must contain the basic elements of: (1) offer and acceptance,

(2) consideration or obligation (3) competent parties and (4) a lawful purpose.(51:p. 588) The objective of the Purchasing Officer is to obtain "the right quality," from "the right source of supply" in "the right quantity" at "the right time."(51:p. 17)

The type of contract used is a function of the assignment of financial risk and the objectives desired. In a Cost Plus Fixed Fee contract, the Government assumes all of the risk of cost variations. The contractor is obligated only to provide his best effort. On the other side of the scale, the contractor assumes all of the cost risk in a Fixed Price Contract. If the cost realized is less than the agreed price, he makes a profit. If it is less, he suffers a loss. In between these two, are found fixed price with escalation, fixed price with redetermination and various other cost sharing programs. In addition to cost sharing, which in itself is a form of incentivization, incentives on schedule and performance of the contract can be written into the terms to achieve the desired government objectives. The final type of contract is a Time and Materials contract in which the government pays only the costs with no fee. This type of contract is common with Universities and other non-profit organizations.(51:pp. 125-132)

10. Armed Services Procurement Regulations

A section of the Armed Services Procurement Act of 1947 authorized the Services to reach agreement upon the performance of procurement functions by one service for

another and authorized the creation of joint or combined agencies to perform procurement operations. It further provided a common, uniform basis for procurement by all military services. The present Armed Services Procurement Regulation (ASPR) grew from this standard and unified approach to procurement.

The ASPR sets forth the underlying principles, policies and procedures on a vast array of subjects relating to DOD procurement.(9:pp. 85-87) Some examples of topic areas covered are: Use of Formal Advertising, Use of Negotiation, Determinations and Findings, Types of Contracts, Patents, Data and Copyrights, Taxes and Contractor Industrial Labor Relations.(7:pp. 1-12) The ASPR is issued by the Assistant Secretary of Defense (Installations and Logistics) by direction of the Secretary of Defense and in coordination with the Secretaries of the Army, Navy and Air Force and the Director of the Defense Supply Agency. Its Purpose is to establish "uniform policies and procedures relative to the procurement of supplies and services under the authority of Chapter 137, Title 10 of the United States Code, or under other statutory authority."(7:p. 1:1)

D. THE DEFENSE SYSTEM ACQUISITION REVIEW PROCESS

The Defense System Acquisition Review Committee concept was created by Deputy Secretary of Defense David Packard to combat the uncontrolled cost growth in weapons system and the Department of Defense procurement budget that resulted

from the "Total Package Procurement" approach to weapons system procurement. "Total Package Procurement" is the inclusion of the entire development and production of a weapons system under one fixed price contract. The objective of the process is to prevent a weapons system from moving into the commitments of the next stage of development before it is ready to do so. The first decision (DSARC I) is the Program Initiation Decision. The primary concerns of this decision point are that the Service need has been substantiated, the proposed system performance meets the need, that a plan exists for evaluation of alternatives and that the business approach is consistent with program objectives, affordability and predictable risks. The objectives of the Full-Scale Development Decision (DSARC II) are to reassess operational need, to evaluate the adequacy of alternative approaches, to examine the adequacy of the test and evaluation approach, to verify readiness to enter full-scale development or detailed design and to check the soundness of the business approach. The military worth and economic affordability of proposed alternatives are also examined. The purpose of the Production/Deployment Decision (DSARC III) is to ensure the system is fully ready to enter production. The logistic support plan, test results, business approach, and operational need are examined. On some occasions, the result of DSARC III is the authorization of only the lead ship or the first production run. In this case, a DSARC IIIA is held to authorize further production.

The principal members of the DSARC are the DDR&E, ASD(I&L), ASD(C), ASD(SA&E), and, for programs within their areas of responsibility, the ASD(T), and the ASD(I). Other Assistant Secretaries of Defense are invited to attend when appropriate. The Chairman of the Joint Chiefs of Staff, the cognizant DOD Component head, the Deputy Director (T&E), ODDR&E and the Chairman of the Cost Analysis Improvement Group normally serve as advisors to the DSARC principals.

The major document of the DSARC process is the Decision Coordination Paper (DCP). It is a summary document providing a broad overview of a major defense system program. It records the primary information on the program, the thresholds, the issues and risks, the alternatives, the reviews, the rationale for the decisions, the affordability of the system, and finally the decision of the Secretary of Defense. The DCP and the DSARC process are conducted in accordance with DODINST 5000.2, The Decision Coordinating Paper (DCP) and the Defense Systems Acquisition Review Council (DSARC).

E. DEMAND

The demand for Naval ships systems is a function of the perception of the need by the Department of Defense, the President and Congress and the value of the Weapons procurement program in relation to other demands on the National Economy. These factors regulate the input of dollars into weapons system acquisition. The availability of design and production assets and the competition of civilian products govern industry's response to this demand.

1. Perception of Need

The classic view of the weapons system acquisition process is that the Department of Defense in examining intelligence perceives a change in the threat to United States security. The United States's strategy is then modified, producing the requirement for a change in forces. This change may take the form of an increase or decrease in numbers, a change in the type of weapons or relative quantities or lastly the need for a completely new weapon. Programs are generated to fill the need which comes from the difference between forces in being and force requirement. Funding is then obtained from Congress to support these programs.(38:p. 9) With the possible exception of the Polaris program, no Navy program could be found by this author that followed this classic pattern.

Three sources of generation of new program requirements are identifiable. The wear-out or technicological obsolescence of the existing system is the most common reason for the establishment of a program for a new system. Most of the new ship acquisitions fall under this category. The second reason for establishing a new program is to capitalize on the development of new technology. This technology is usually developed with no specific application in mind. The advancement in laser technology and underwater acoustic capabilities are examples of this form of program initiation. Finally, the perception of a specific threat provides the need to counter or match that threat. The development of

the surface to surface missile and the close-in weapons systems are examples of this form of need recognition.

2. Political Environment

The final authority on the recognition of need is the President's request, as approved in the authorizing and appropriating legislation of Congress. The President, and finally Congress, must balance the stated requirements of the Department of Defense against the requirements of all other demands on the Government. These requirements are further compared to expected revenues and the expected results of a deficit (or surplus) or a specific size of the economy of the nation. The status of the economy, the national and international political situation and the desires of numerous lobbyists and political groups are all balanced against the Department of Defense rationale to arrive at the final "need" for new or modified weapons systems.

The political environment also fosters the inclusion of social legislation in the government procurement program. The magnitude of defense expenditures make it a likely candidate for attempting to accomplish social change. As a result, numerous laws and regulations are created to assure equal opportunity, minimum wages and the like within industries supplying the government. In an attempt to control the process, the legislative and executive agencies also create numerous administrative requirements. Most of these are designed to cure some problem perceived in the process, but

all have the effect of limiting the freedom of action available to those responsible for weapon system acquisition. (13:p. 51)

3. Production

The final ingredient necessary to obtain a new weapons system is the production capability. This is the ability to gather together the men, material machines and know-how required to actually produce the weapons system. In this arena weapons system production must compete with the multitude of other industry requirements.

Figure 16 is a representation of the basic interrelationships that exist in determining the supply and demand for a weapon system.

F. FINANCING

Two areas of funding are of interest to the Navy weapons system acquisition process. The first is the process by which the Navy receives the funds to purchase the systems. These funds are paid to the contractor in various fashions to purchase his material and services. The second area of interest is that of contractor financing. The contractor of major weapons systems generally does not have sufficient capitalization to accept the contract, manufacture the system and accept payment upon successful delivery. As a result, several methods of financing the capital equipment, material and labor required to develop and manufacture a weapons system are available.

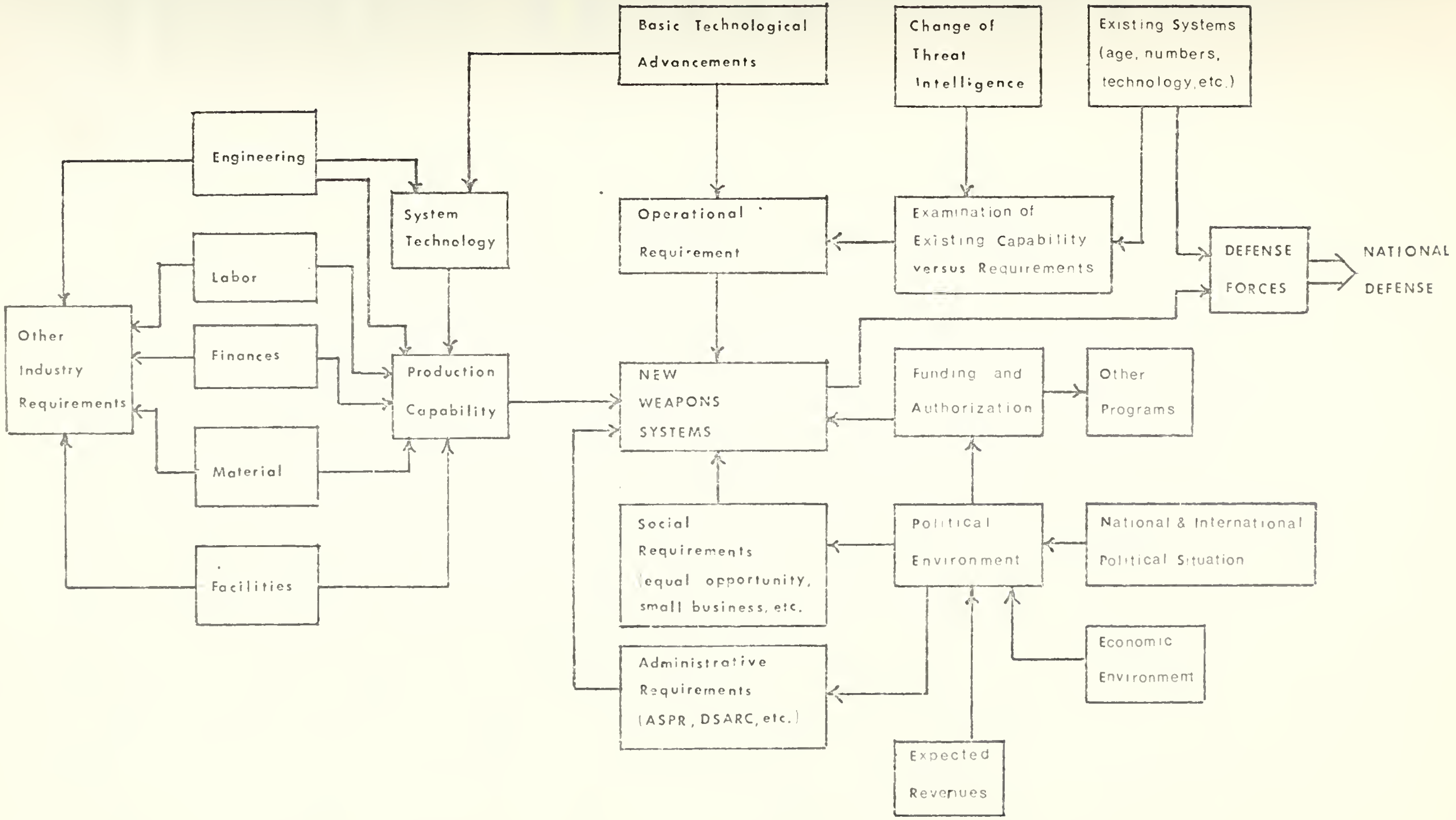

Basic Technological Advancements
Change of Threat Intelligence
Existing Systems (age, numbers, technology, etc.)
Engineering
System Technology
Operational Requirement
Examination of Existing Capability versus Requirements
DEFENSE FORCES
NATIONAL DEFENSE
Labor
Other Industry Requirements
Finances
Production Capability
NEW WEAPONS SYSTEMS
Funding and Authorization
Other Programs
Material
Social Requirements (equal opportunity, small business, etc.
Political Environment
National & International Political Situation
Facilities
Economic Environment
Administrative Requirements (ASPR, DSARC, etc.)
Expected Revenues

Figure 16 - Interrelationship of Factors Involved in the Acquisition of New Weapons Systems.

1. The Budget Process

Within the Department of Defense, the budget process is divided into three phases: Planning, Programming and Budgeting. The Planning Phase starts each year with the issuance by the Joint Chiefs of Staff (JCS) of Volume I of the Joint Strategics Objective Plan (JSOP). Following this, the President normally issues his annual Foreign Policy Guidance. The two are integrated by the Secretary of Defense (SECDEF), who issues his strategy guidance in the Defense Policy and Planning Guidance (DPPG) document. Following this, JCS issues JSOP Volume II. Based on JSOP Volume II, the results of Selected Analysis and the reclama to the DPPG, SECDEF issues the Programming Policy Guidance Memorandum (PPGM) which contains Defense Policy and Force Planning (an update of the DPPG), Fiscal Guidance, Materiel Support Planning Guidance and Guidance for Program Objective Memorandum (POM) Preparation. With the issuance of the PPGM, the Planning Phase is considered complete.

The Programming Phase begins with the submittal by JCS of the Joint Forces Memorandum (JFM) and by the individual Department of Defense (DOD) components' Program Objective Memorandum (POM). The POM is developed within the constraints of the PPGM and the boundaries of the planning data presented by the JFM, to satisfy all of the assigned functions and responsibilities of the Five Year Defense Plan (FYDP). Differences between the JFM and POM are addressed in a series of Issue Papers prepared by the Program Analysis and

Evaluation Office of the Office of the Secretary of Defense. Based on these inputs, SECDEF issues tentative Program Decision Memoranda (PDM) and after the reclama, amended PDM's. This completes the Programming Phase.

Based on Budget Policies promulgated by the President, the Office of Management and Budget (OMB) provides budget guidance to SECDEF, who in turn issues Budget Guidance to the DOD Components. DOD Components submit Proposed Budgets to SECDEF, who issues a series of Program Budget Decisions (PBD) based on the Component Budgets, initial Budget Hearings and reclama to the draft PBD"S. Any unresolved items remaining at this time are discussed in joint meetings between SECDEF, JCS, and the Secretaries of the various components. SECDEF makes his final decisions and submits the proposed DOD budget to the OMB. The OMB combines it with all other Federal Budgets and presents it to the President for final review and approval.(38:pp. 12-18)

The staff of the Congressional Budget Office (CBO) analyzes the the Current Services Budget and the President's Budget upon receipt. Hearings are conducted before the various applicable committees on the critical issues, the economic impact of the budget, the allocations and priorities and the projected requirements of the various departments of the government. The Budget Committees create the First Concurrent Resolution based on the CBO budget analysis and the projected requirements reports of other committees. A conference report and a joint statement of managers allocating

targets are adopted and other committees report all authorizing legislation for the coming fiscal year. The applicable committees report authorizing, appropriating and revenue bills and they are passed. Following this, the CBO drafts the Second Concurrent Resolution, which must be debated and passed before the beginning of the fiscal year on 1 October.(78:pp. 16-19)

2. Methods of Financing the Contractor

There are five ways of financing Government contracts: Private financing without Government guarantee, progress payments in customary amounts, guaranteed loans, progress payments in unusual amounts and advanced payments. Of these methods, the most preferred is that of private financing without Government guarantee. The contractor is able to assign his right to payment to a commercial financial institution as security to assit in obtaining this type of loan. Due to the magnitude of the capital requirements, however, most contractors require at least some financial assistance from the government. Progress payments in customary amounts, based on some measure of completion of the system, are the preferred way to supplement private financing. Private loans which are guaranteed by the Government are the next most preferred method of financing. No federal funds are expended under this method unless the contractor defaults. The least desirable method is the use of advance payments as they usually involve greater risk to the Government than the other types of financing, hence closer supervision.(56:pp. 96-101)

Finally, Public Law 85-804 (as implemented by Executive Order 10789, dated 16 November 1958, Section XVII of the ASPR and departmental regulations) provides authority for granting relief to contractors in certain extraordinary situations. By the terms of the Act, the President is empowered to permit agencies concerned with national defense to enter into or to modify contracts without regard to other provisions of law. The three types of relief available are amendments without consideration, amendments correcting mistakes and ambiguities and formalization of informal commitments.(56:pp. 252-253)

IV. TASKS REQUIRED IN SHIP ACQUISITION

A. SHIP ACQUISITION TASKS

As previously described, a ship is an integrated set of individual systems designed to accomplish a mission. The mission itself may be modified based on the results of successive study and design iterations, but the end result is an integrated ship.(62) The major categories of tasks required to produce a naval ship are: Development of individual systems, integration of the systems, construction of the ship, financing, and control of the process. Additional tasks that are required, but are not directly related to the development and construction of the ship relate to the inclusion of the ship in the overall defense planning, the planning itself and the tasks related to the initiation, funding and control of basic research which ultimately provides the technology base that leads to the individual systems.

The development of individual systems goes through the phases of research or technology buildup, conceptual exploration, validation, full scale development and finally adaptation to the specific application. This process is described in chapter 3. Of major significance is that individual systems in all stages of development may be represented in any one ship. A given ship design may include a sonar system with an untried technology, a communication system

that is in use in numerous existing ships and a myriad of other systems whose state of development is somewhere between these two. The only common requirement is that all systems must be operationally ready when the ship is to be operationally ready. Even this requirement is not sacrosanct, however, for many modern ships are commissioned with "space and weight" reserved for a system that is not ready for operational use on a ship. The general requirement to have the systems ready does have the effect of imposing markedly different required rates of development for different individual systems and a large variation in the degree of risk associated with the inclusion of the different individual systems within the ship design.

The integration of the multitude of different systems into one ship is a task of major magnitude. Not only must changes be made in individual systems to accomodate them to the ship, but changes in one system can have marked effect on another system. As an example, a relatively minor increase in the power requirements of one or two of the systems can force a commensurate change in the power requirements of other systems or an increase in the power generation capability. This generally means that additional volume and weight must be alloted to power generation which will result in a growth in the ship size or tradeoff with some other system or systems originally allotted the space and weight. If the ship grows then either a decrease in ship's speed must be accepted or the propulsion power must be increased -- with further increases in volume and weight required. Design

control must be exercised to coordinate these changes and minimize the impact on the ship as a whole.

The funding of the ship is a major task in itself. This starts from the budgeting of funds for research and development for the technology, continues through the funding of the ship itself and finally concludes with the payment to the various contractors, including the settlement of any claims which arise from the development and construction of the ship and its systems. The sheer magnitude of the funds expended to produce a ship and concern with the growth of the cost of a ship have made this a task of particular significance in today's environment.

Finally there is the requirement to control and monitor the development and construction of the ship and its systems. This can be roughly divided into control of the project by external agencies and control of the development and construction by the group of individuals directly charged with the management of the project. In the case of a major weapon system, this group is the Project Office. In the case of a smaller system, it is a group within the systems command which may be responsible for the development of several individual systems.

The following specific listing of tasks related to the procurement of a ship are taken from the Patrol Frigate Preliminary Allocated Baseline Design Plan,(63) the Patrol Frigate Project Net,(90) and the Management of Ship Design at the Naval Ship Engineering Center,(87:p. 2-6) In

addition, the author's experience on the new construction crews of three ships is included. This description of tasks is provided to allow comparison of individual tasks with each other and to the applicable portions of the ship acquisition structure.

B. SYSTEMS ORIENTED TASKS

1. Tasks Associated With Individual Systems

The development and manufacture of an individual weapons system is an iterative process in which the design features of the various components and finally the test results are balanced to provide an operating system that supports the needs of the ship. The individual tasks required to produce the system are:

a. Technology development - Acquisition of the basic scientific basis for the system and the engineering "know how" to construct it.

b. Specification creation - Development of an adequate description of the system and its components to enable the Navy to communicate its requirements to the producer of the system.

c. Component design or selection - Individual components are selected that when aggregated will accomplish the the purpose of the system. These components may be "off the shelf" items which may be used in their existing configuration or with modifications or they may be designed for the specific application.

d. System design and integration- The coordination of the individual components to accomplish the purpose of the system. The system design and integration, the component design or selection, the specification creation and to some extent the technology development all take place essentially simultaneously as a iterative process to meet the system goals. The whole process, like the system itself, is derived from a technology base.

e. Component manufacture.

f. Component test - Proof that the individual components will meet the requirements of the system.

g. System manufacture - Physical interconnection of the components to produce the complete system. The construction of prototypes at land based test sites or on board existing ships is done to prove the system at various points in the development process.

h. System Test - System testing begins with the testing of a breadboard version of the system designed to prove the system concept, through prototypes that prove the operability and capability of the system and finally to the system as installed on the ship.

i. Software production - An array of technical manuals, blueprints, preventive maintenance requirements and other supporting documents must be manufactured to support the continued operation and maintenance of the system aboard ship.

2. Integrated System/Ship Tasks

The following are tasks that cross system boundries. These include not only the bringing of the systems as an integrated whole, but the conceptualization design and construction of the ship as an individual entity.

a. Concept formulation - At some point, the determination is made that a new ship or ship type is required for the active fleet. As stated earlier, this may result from the obsolescence or physical aging of the existing ships in the fleet, the advancement of technology or a re-evaluation of the threat. Theoretically this need is expressed in terms of operational need instead of specific characteristics, but this is frequently not the practice.

b. Specific requirements determination - Given that there is a specific need to counter a threat, that there is the desire to exploit new technology or that replacement systems must be procured, the requirements in terms of cost, schedule and performance are developed for the ship. In this context, specific requirements determination is used to mean development of the requirements for a specific ship. In other contexts, the term "requirements determination" describes the entire process of establishing the need and requirements for a new weapons system.

c. Inclusion in Defense Planning - When the need for an integrated system has been established, the integrated

system (ship) must compete with other Department of Defense programs for a position within their long ranged planning. This is a necessary prerequisite for becoming a viable program.

d. Authorization - Once the requirements for a specific ship have been established, this ship must be "sold" to Congress. Without the authorization of Congress the ship may not be developed and constructed. It should be noted that the requirement for authorization and later appropriation exists for major individual systems themselves.

e. System Integration/Arrangement - This is the design and manufacturing process of bringing the individual systems together to make a whole ship. The degree of coordination required to accomplish this task is significant. Designers must not only ensure that a pipe from one system does not run through the physical space occupied by a pipe for another system, but that design goals such as maintainability and accessability are maintained in the ship as a whole.

f. Multiple system testing - Testing to ensure the compatability of the ships systems. In some instances this has been done initially in a land based test site to provide information in advance of the testing on the ship itself.

g. Ship Testing - The testing of the ship as a whole. Most of this testing is conducted at sea and includes operation of all systems in all modes. The major tests prior to

delivery of the ship are Builder's Trials, Acceptance Trials and Board of Inspection and Survey (INSURV) Trials.

h. Acceptance - Transfer of ownership of the ship to the Navy.

C. CROSS SYSTEM TASKS

Cross system tasks are those that apply to more than one system. Although some of these may be applied to one system at a time, like reliability assurance, they are applicable to more than one system and are generally subject to an effort that encompases all systems. Others, like Configuration Management, apply to all systems by their very nature.

1. Configuration Management

Configuration management is the control of the design of the ship to ensure that it meets the final requirements of the ship and that the various individual systems are coordinated. Some form of design control, technical review and change control are routinely used to accomplish this end.

a. Design Control is the coordination of the various design groups to achieve a compatible set of design. In the case of the Patrol Frigate, it was also used to limit the growth of the ship. Critical control parameters, such as space, weight and manning were identified and allocated to the individual system. These were then tracked throughout the design process to ensure that the ship retained its desired size, displacement and manning.(87:p. 5-4)

b. Technical Review is plans and blueprints by applicable divisions to ensure that the goals of the design are being met and that the individual system details remain compatible with one another. This review also serves the function of providing the opportunity to verify the reliability, maintainability and availability of the system or portion of the system being reviewed.

c. Change Control is required to ensure that changes in one system are taken into account in the design of other systems as well as insuring that changes to a part of a system are accounted for in the remainder of the individual system. Some form of formal change control is routinely established that requires specific approval of applicable people to change the system. Establishment of formal change control too early slows down the design process by requiring too much administrative effort to accomplish the iterative process used to arrive at the final design of the systems. If formal design control is established too late, lack of coordination will create costly inconsistancies between designs. An alternative step between general design control and formal change control is the establishment of control of interfaces between systems. This method was used in the design of the Polaris missile system.(86:p 251)

2. Test and Evaluation

In order to prove that the ship meets the requirement imposed, the ship, the systems and the individual components

must be tested. The most valid test would be to involve the ship in a battle and measure its success. The two drawbacks from this absolute measure of effectiveness are the shortage of wars to be used for test purposes and the inability to provide uniform test conditions and isolate the effectiveness of individual systems or components. As a result, tests are devised to verify operational characteristics starting at the component level and working up through evaluation of the ship as a complete entity.

Before the ship is assembled completely, quality control is exercised to give reasonable assurance that the final objectives of the ship construction will be met. This measurement of inputs into the process of ship construction is required to provide reasonable assurance that the final product will meet the requirements. Many attributes can not be measured or at least can be measured with significantly more difficulty once construction is complete. As an example, the quality of steel is much more difficult to measure after the steel has been used in the ship and the cost of replacing steel that does not meet the requirements for the strength of the ship makes evaluation of quality before installation mandatory.

To accomplish the objectives of test and evaluation, including quality control, requires facilities, personnel, test equipment and appropriate procedures and plans. These must be integrated to achieve the results desired and coordinated to insure that they minimize the impact on the ship

schedule. The cost of the testing should be weighed against the confidence derived from the testing to establish what should be tested and to what extent it should be tested.

3. Manning

When a ship is delivered to the Navy, personnel must be allocated to operate and maintain the ship. They must further be trained in the techniques required to operate and maintain the ship. Depending on the uniqueness of the ship and its systems, the training for operation and maintenance can be a lengthy and difficult process. As a result, the manning requirements for the new ship in terms of personnel with specific talents must be anticipated well ahead of time and plans must be made to fulfill the requirements of the new ship. This is even more difficult for a nuclear powered ship where the requirement exists that the ship be operated by a Navy crew starting with the very first stages of operational testing, well before the first time the ship goes to sea.

4. Reliability, Maintainability and Availability

A ship or system that is incapable of operating when called upon is obviously incapable of meeting its operational requirements. Hence a need exists to provide systems that will not only measure up to their requirements, but will do so reliably when called upon. A system that will meet its full operational requirement only fifteen percent of the time obviously does not provide the ship with the needed capability.

Reliability is defined as the probability that a system or product will give satisfactory performance for a specified period of time when used under stated conditions. Maintainability is a characteristic of design and installation which is expressed as the probability that an item will be retained in or restored to a specified condition within a given period of time. When maintenance is performed in accordance with prescribed procedures and resources. Availability is a combination of the reliability and maintainability and is defined as the probabiltiy that a system or equipment, when used under stated conditions, will operate satisfactorily when called upon. Hence a required degree of availability must be designed into the system and testing must be done to prove that the availability goals, which are derived from the reliability and maintainability, have been achieved.(10:pp. 5-15)

5. Supply Support

Supply support includes the planning for and provision of materials required for the operation and maintenance of the ship's systems. Consumables are required for routine operation of the system, including periodic preventive maintenance. If the consumables are common to other systems, the increased potential requirements must be reflected as an increase in the quantities purchased. If the consumable is not common to other systems already in use, its demand must be estimated and it must be purchased and incorporated in the supply system in sufficient time to support ships operation.

The second type of supply support required is the provision of repair parts for corrective maintenance. Failure rates must be estimated and parts must be stocked based on analysis of the effect on operational capability of the failure, the cost of stocking, manufacturing or purchasing the part and the length of time that will be required to obtain a replacement.(10:pp. 52-53)

6. Maintenance Support

Both preventive and corrective maintenance must be supported to ensure effective operation of the ship. In addition to the spare parts support noted above, planning, facilities, personnel, equipment and software must be provided. The planning begins with the establishment of the maintenance policy to be used on the systems and continues through the details of providing the correct tools to accomplish the maintenance. With the distribution of on ship and off ship decided, personnel with the correct types of training must be provided for and facilities must be established or designated for the expected maintenance. In the case of existing facilities, the present work load must be measured and allowances must be made for the additional load incident to the introduction of the new ship(s).

Finally, a wide spectrum of software must be provided to give the needed direction and information to accomplish the maintenance. This includes technical manuals, blueprints, preventive maintenance requirements, data sheets and many

other types of software. Without this type of support, repair of the system is extremely difficult if not impossible to perform.

7. Scheduling

Throughout concept formulation, design and construction the various tasks associated with the ship development and construction must be coordinated to ensure that specific tasks are completed when they are needed to support the start or continuation of other tasks. There are several systems in use to accomplish this end, but the purpose of each is to ensure that the prerequisites of a specific event have been met at the time the event takes place. As an example, the parts for a turbine generator must be manufactured or received in time to support assembly, which in turn must be complete in time to support the shipping date. The turbine generator must be received in time to support an installation date that is dependent on hull closure and/or system completion. System completion is required to support system testing so that the system will be ready to support ship testing -- and so forth.

If there were no uncertainties in the development and construction of a ship, the scheduling could be done once and followed. In reality, equipment arrives late, parts fail in testing, unforeseen interferences prevent simultaneous accomplishment of two jobs, etc. This type of occurrence requires the schedule to undergo frequent revision to retain its usefulness. Additionally, to be effective, it must show the effect on other systems and on the ship as a whole of not meeting a requirement at the time specified.

8. Operational Software Provision

To effectively use the ship and its systems, procedures must be established for its operation. Documents covering the full range from tactical employment to operation of a specific piece of equipment must be created. These are derived from the initial planning and design of the ship and its systems and should be revised as test results and operational experience provide better information about the systems.

D. FINANCES

To be successful, a weapon system must have adequate funding. The definition of what constitutes "adequate" for a particular project varies widely with the point of view of the person defining the appropriate level of funding, but the obtaining of funding, the management of funds once received and the disbursement of these funds are major tasks in the process of development and construction of a ship. The ability of applicable offices in the Department of Defense to obtain and properly use funding have a significant effect on the cost and performance of the ship.

Funding is not only a task, in that the mechanics are required for ship acquisition, but it is a means of communication and control as described in the previous chapter. The tasks related in this sections are requirements that the structure must accomplish.

1. Budgeting Task

The first step in funding of a weapons system is getting it included in the annual budget. This requires an

annual defense of the project at each level of budget review. This culminates in the presentation of the President's budget to Congress and more recently the development of a Congressional budget by the Congressional Budget office and Budget Committees.(18:pp. 16-18)

2. Appropriation Task

Technically "appropriation" is the provision by Congress of funds to the Executive, Judicial and Legislative Branches for the operation of the government, including provision of funds for procurement of major weapons systems. Used in the context of this thesis, it is the effort necessary both by Congress and applicable portions of the Executive branch to draft and enact the Armed Services Appropriations Bill providing funds for the development and construction of major weapons systems.

3. Allocation Task

Once the funds are appropriated, they are allocated by the Department of Defense to the various services who further allocate the funds to specific activities. Although the funds are appropriated for a specific purpose, there is sufficient freedom in the use of these funds, both in the bill itself and in the practice of reprogramming, to allow movement of funds from one project to another. Hence a project office must insure that they actually get the funds and further protect them from reallocation during the year. The Offices of the Secretary of Defense, the Secretary of Navy, the Chief of Naval Operations, the Chief of Naval Material

and the Chiefs of the various system commands must apply the available funds to the uses that will, in their views, most effectively support the defense of the United States.

4. Contracting/Obligation Task

Once the funds have been allocated, they are obligated to various private and public organizations to procure the goods and services that are required to obtain the ship. The specific type of contract used effects the way in which the performing organization will be paid, hence, in the case of a private corporation, its profit on assets applied. In the case of a public organization, this "business" is the justification for its existance.

5. Payment (Expenditure) Task

Payment or expenditure is the actual disbursement of funds for the goods and services received. This is done in accordance with the contract in the case of a private organization and is done by a transfer of appropriations and subsequent disbursement by the performing organization in the case of public organizations.

6. Readjustment Task

Frequently during the course of a contract or upon completion of the contract there is a disagreement between the government and the contractor over the terms of the contractor. This results in an attempt by the contractor, the government or both to change the contract. Adjustments may be made under the "Claims" provision of the contract, Public Law 85-804, Armed Services Board of Contract Appeals

decision, Government Accounting Office decision or court decision. The total process may delay final payment for years.

7. Financial Management

The planning, directing and controlling the use of funds at each level of management involved in weapons system acquisition is a major undertaking. If the flow of funds does not match the desired rate of work, costly delays or loss of appropriated funds will occur. Staff organizations at each level in the Department of Defense are charged with controlling the funds and there is an increased awareness of the necessity for careful management. There is an increasing trend toward having business managers even in the Project Offices.

E. PROGRAM CONTROL AND MONITERING

If the Program Office is viewed as the focus of the ship acquisition process, it is responsible to and acts under the direction of those who provide the funds and for whom the ship is being built. Senior offices in the Department of Defense and the Office of the President issue general guidance and specific instructions relating to weapons system acquisition and procurement in general and the project specifically. Congress not only passes legislation relating to procurement and the individual projects, but provides direction in hearings and in meetings with congressmen and members of their staffs. The courts provide opinions that

act as constraints on possible alternative government-civilian relationships.

The project organization, in turn, provides direction to contractors and other organizations working on the project. This takes the form of contract terms, memoranda of agreement, specifications, conferences, etc. Status of the project is provided by the contractor to the project and by the project to the superior organizations to allow monitering of progress. This same direction flow downward and information flow upward can be viewed from any point in the chain from the taxpayer through the Congress, the Office of the President, the various organizations in the Department of Defense and the performing organization (usually the contractor) until it finally reaches the worker on the project.

Program monitering and control can be viewed as existing in two principle areas -- fiscal and physical progress. These two areas are obviously very much dependent upon one another, but are frequently handled by two separate portions of each organization involved in the weapons acquisition process.

1. Expenditure Monitering and Control

The notoriety of large cost overruns in major weapons system acquisition has focused attention on the need to adequately control expenditures. Lack of "real time" information on expenditures has meant that a program could be in serious trouble long before the appropriate managers realized that expenditures were well beyond plans. Performance Evaluation and Review Technique (PERT) Cost System and Cost

Schedule Control System Criteria (CSCSC) are two methodologies that were created to give the Project Manager better control of expenditures relative to the performance of the project. The specific financial direction of the contractor is in the terms of the contract. Here the method of determining the schedule of payment is described and the price of the ship, including incentivation if used, is established.

Status of expenditure is routinely reported to Congress via the Office of the Secretary of Defense in form of the Selected Acquisition Report (SAR). Expenditures are also reported in the normal fashion for appropriated funds. Non-recurring reports are made based on investigations made by the Government Accounting Office and the Defense Contract Audit Agency.

2. Program Progress and Control

The progress of the contractor is monitored by local Defense Department representatives. In the case of the prime contract for a ship, the agent for the government at the shipyard is the Supervisor of Shipbuilding. Subcontracts are monitored by the prime contractor and progress on government furnished equipment is monitored by the area Defense Contract Administration Office.

The Selected Acquisition Report contains information pertaining to the performance of the project in relation to technical goals and schedule in addition to the financial information. The Defense System Acquisition Review Committee

reviews program progress prior to allowing the program to progress to the next phase of development or production.

F. SYSTEMS

As previously noted, a ship can be considered a set of systems that operate together to accomplish the mission of the ship. Many of these systems are large enough and expensive enough to have been developed under the auspices of separate project organizations but all must be brought together and coordinated. The major categories of systems are:

1. Sensors - The detection systems that provide input information to the weapon systems. Included: Air and surface search radar, fixed and towed array sonar, electronic surveillance.
2. Combat Systems - The weapons system of the ship. Included: Fire control systems, Weapon delivery systems, Weapons themselves.
3. Command and Control Systems - The systems used to coordinate the various systems on the ship with each other and with the systems on other ships. Included: Automatic Command and Control, LINK 11.
4. Communications Systems - Means to communicate external to the ship. Included: Visual signalling, secure and unsecure radios, cryptographic equipment.
5. Interior Communications, Ship Control and Navigation - The systems used to communicate within the ship and to direct the ship. Included: Interior telephones, ship

control information systems, inertial navigation systems, navigational data transfer systems.

6. Propulsion - The means by which the ship is propelled through the water. Included: Main and auxiliary propulsion systems.

7. Auxiliaries - The systems that provide the necessary services to allow other ship systems to operate. Included: Electric power generation and distribution, high and low pressure air, hydraulics, air conditioning, damage control, fresh and salt water cooling, degaussing, auxiliary steam, deck machinery, replenishment equipment, refregeration.

8. Accommodation - Support of the crew. Included: Berthing and eating facilities.

9. Support - Area required to provide space for the administration and support of other systems. Included: Offices, work spaces, spare part store rooms, ammunition storage areas, fresh, dry and frozen provision store rooms.

10. Hull - The physical hull and items that related to the ship as a whole. Included: Structure, ship stability, weights, appendages, anti-fouling.

V. TASK ACCOMPLISHMENT UNDER THE EXISTING SYSTEM

Specific examples are provided to illustrate the effects of apparent mismatch of structure and task. Conclusions relating to the mismatches are drawn in the following chapter.

A. THE PATROL FRIGATE

In September, 1970, OPNAV initiated a feasibility study that resulted in a December recommendation that the "Navy should expedite action on the new design escort ship... to be built in quantity for a unit cost of about $50 million...." NAVSHIPS considered this feasible and CNO approved proceeding into the Conceptual Phase in January 1971. In early May, CNO selected the payload characteristics, approved a lead ship-follow ship concept in lieu of a more time-consuming and costly prototype and set a provisional full load displacement of 3000 tons. In mid-May, CONMASHIPS stated that the 3000 ton limit was unrealistic and suggested that a 3500 ton limit was more practical, but felt that limiting cost was a more appropriate control. In late May, CNO selected the single shaft propulsion alternative, established a $45 million upper limit of follow ship cost in FY 73 dollars and set a 3400 ton upper limit on full load displacement.(43)

With this process, the Patrol Frigate became the Navy's first "design-to-cost" ship. A "design-to-cost" weapon system is one where the cost target is set before the design

begins and is theoretically given equal consideration with schedule and performance in tradeoffs. With the establishment of a 185 man crew size, it became one of the most severly constrained warships ever to be designed. High degrees of automation, reliability and maintainability were required to remain within the crew size restraint. Extremely effective use of weight and volume were required to remain within the displacement limits. These constraints, in the view of the author, would require considerable innovation and a significant degree of risk to complete the design and production of the ship. The development estimate of the program was in excess of $3 billion and had the direct interest of the Chief of Naval Operations. The cost, the CNO interest and the first attempt at "design-to-cost" combined to provide a high degree of visibility for the project.

The lead ship was originally scheduled for delivery in June 1977, providing a period of 6½ years from approval to proceed with the Conceptual Phase until completion of the first ship. The resulting foreshortened development period required a different approach to the procurement for the traditional one.(67:p. 83) The follow ships were, however, scheduled to start after completion of the lead ship. This was intended to allow modification of design details as required, based on the experience of the lead ship.

The design of the lead Patrol Frigate was done in four stages: Functional Baseline, Preliminary Allocated Baseline, "Lead" Ship Allocated Baseline and Detailed Design. The specific phases were:

> "Functional Baseline (FBL) -- The FBL, which was developed by NAVSEC prior to the involvement of the two shipbuilder participants, is essentially equivalent to a preliminary design although it presents a greater level of engineering detail in certain critical areas and includes preliminary ILS, reliability and other technical support studies. The FBL description is generally in an engineering format rather than a contractual format, and formed the basis for the start of the next phase of design--the development of Preliminary Allocated Baseline (PABL). Before starting the PABL, however, the FBL undergoes extensive review by the Navy and the Shipbuilder participants to ensure its adequacy and accuracy."
>
> "Preliminary Allocated Baseline (PABL) -- The next technical baseline, PABL, represents an extension of the results of FBL, and the production of the end documents in contractual formats. The PABL was prepared by NAVSEC with Bath and Todd (the two shipbuilders) participation and Independent Contractor (Gibbs and Cox) assistance. It is essentially equivalent to a contract design, but again is somewhat more detailed in certain critical areas, and includes preliminary technical support plans (ILS, reliability, manning, etc.). It represents the Navy's and the Technical Community's (NAVSEC and NAVSHIPS) version of what the technical portion of the "lead" ship contractual package should contain, and is quite similar to a conventional contract design in format."
>
> "Lead Ship Allocated Baseline (LSABL) -- The PABL package received extensive review by the Navy Material Commands, COMCRUDESPAC/LANT, INSURV, and Bath and Todd who submitted their comments to NAVSEC. All of the comments were formally reviewed and adjudicated to decide which should be included in the Lead Ship Contractual Package. After decision and incorporation of applicable comments the LSABL was produced, and formed the basis for negotiation of the "lead" ship construction contract with Bath."
>
> Detailed design -- Translation of the LSABL into drawings that can actually be used in the construction of the ship was done by Bath, with assistance on a subcontract basis from Gibbs and Cox. These designs, together with equipment procurement, production planning and actual construction experience from the "lead" ship form the basis for the Follow Ship Allocated Baseline (FSABL) which is the basis for the solicitation of competitive proposals for the construction of the first block of "Follow" ships. (67:pp. 87-88)

Although the Patrol Frigate was intended to be a "low risk" weapons system acquisition, significant innovations

were incorporated in both the acquisition process and the technology of the systems themselves. The acquisition process innovations were the employment of NAVSEC to create the ship design, the involvement of two shipbuilders to ensure producability, the "design-to-cost" concept, the use of different types of contracts, appropriate to the risk involved, as the development progressed, and the use of Propulsion System and Combat System land based test sites to reduce difficulties in the installation of the gas turbines and fire control system in the "lead" and "follow" ships. Unproven equipment included the 1000KW supercharged diesel generators, the automatic electric system, the adapted Canadian 505 type sonar and the MK 13 Mod 4 Guided Missile Launcher.

The Patrol Frigate Project Office (PMS 399) is an organization of 46 people charged with directing the development, integration and construction of the Patrol Frigate. "Product" oriented personnel are responsible for the lead and follow ships. "Functional" personnel within the office are responsible for technical direction, Test & Evaluation, Production & Procurement Planning, Management (including financial) and Integrated Logistics Support (ILS). Theoretically, this office receives its direction from the Ship Acquisition Division (NOP 37) of the Office of Deputy Chief of Naval Operations (Surface Warfare) and from the Escort and Cruiser Directorate (NSEA 93) of the Naval Ship Systems Command. The Patrol Frigate Project Manager is also designated the Deputy Project Manager for the Patrol Frigate in the Surface

Ships Project Office (PM 18) of the Naval Material Command. This does not create the problem that it could, as one person holds the titles of both NSEA 93 and PM 18, but it does present the interesting possibility of the Deputy Project Manager for Patrol Frigates writing letters to himself as the Project Manager of the Patrol Frigate Project. Thus the project office is a mattrix organization within the mattrix organizations of the Material Commands. This already complicated chain of authority is complicated by the joint roles of the Project Manager.

On the production side, the Project Manager theoretically interacts only with the Ship Design Deivision (NSEC 6110) of the Naval Ship Engineering Center (NAVSEC) and the Supervisor of Shipbuilding for the prime contractor (Bath Iron Works). During the early stages of Design, NAVSEC had a design group, numbering about 40 designers, specifically assigned to the Patrol Frigate. When the "Lead" Ship Allocated Baseline was completed, this group was dissolved, depending upon Bath Iron Works and Gibbs & Cox for design continuity.

If the organizations relating to the Patrol Frigate were true Weberian bureaucracies, then the interfaces listed in the preceeding paragraphs would be the only ones existing with the Project Manager. A review of two randomly selected months in the Patrol Frigate Project Manager's schedule of formal meetings showed the wide variety of interfaces shown in Table IV.

TABLE IV

Two Months of Patrol Frigate Project Manager Formal Interfaces

Group	Meetings	Group	Meetings
NSEA 00	7	NOP 02	1
NSEA 00 Staff	2	NOP 03	2
NSEA 93(PM18)	9	NOP 37	3
NSEA 06	3	NOP 43	1
NSEA 09	4	NOP 09	1
NSEA 93	3		
NSEA 98	1		
Other Project Managers	3		
SUPSHIP (Bath)	5	ASN(I&L)	3
Todd Shipbuilding	1	House Armed Services Committee Staff	1
Bath Iron Works	4	Senate Armed Services Committee Staff	1
Subcontractors (various)	6	GAO	1
Land Based Test Sites	2		
NAVSEC (various codes)	3		

Clearly business is frequently not conducted through the designated interfaces, complicating the communication links between the Project Manager and the other principle players considerably. A listing of all meetings and informal contracts of the entire Project Office Staff over a longer period of time would extend the above list manyfold. In general, discussions with the staffs external to the Project Office in NAVSEA, NAVMAT, OPNAV and the House of Representatives indicated that they felt that they served a directive

function, providing no service to the Project Office. As an example, the Reliability and Maintainability Directorate (NSEA 98) staff of the Naval Ship Systems Command felt no obligation to assist the project office in creating viable Reliability and Maintainability Programs, but served solely as an independent reviewing agency of the plans produced by the projects themselves.

For the design of the Patrol Frigate, through LSABL, a design group was created at the Naval Ship Engineering Center. During the early stages of design development personnel were drawn from various functional and staff branches to create the group. Specific personnel from the staffs of the Naval Supply Systems Command, the Naval Ordnance System Command, the Bureau of Medicine and Surgery, the Naval Air Systems Command, the Naval Material Command and the Naval Ships Command were designated as liason members of the design team. They did not, however, move their offices to Hyattsville, Maryland where the design was actually being done.(61:pp. 3-33) These higher physical barriers have a tendency to reduce the ability of the group to act in a concerted fashion.

As the design progressed, the design team increased in size to about 40 people and changed its structure. The functional branches relating to the actual design of hardware were increased in size, but remained essentially the same organizationally. Groups were added for management, integrated logistics, test and evaluation and systems engineering. As a result, the design team was no longer dependent on the

functional branches relating to these disciplines. The functional branches were then free to resume their role of reviewers. Further, the formal designation of liason representatives on the design team was deleted.(52:p. 168)

The Systems Commands and Bureaus, as well as the functional codes of NAVSEC exibit a high degree of organizational complexity. Each branch considers their function effectively independent of the functions of the other branches. The Project Office in Naval Sea Systems Command and, while it existed, the Design Team in NAVSEC were the major coordinating mechanisms. The feedback from the various NAVSEC codes, in the opinion of the author, varied from mediocre to reasonably good. The feedback from the Bureaus and System Commands could generally be characterized as late and over-optimistic.

1. Personnel Turnover

It is generally recognized that personnel turnovers during the course of the development of a weapons system create discontinuities and losses of corporate memory that act to the detriment of the project. All studies of this phenomenum encountered by this author dealt only with turnovers within the project office. The Patrol Frigate Project Office with three Technical Directors, two Integrated Logistics System Directors, two Test Evaluation Directors and two Ship Design Directors between project inception and DSARC III was certainly subject to the problems associated with personnel turnover. Discussions with the Deputy Project Manager indicated that the lack of turnover of

senior civilian personnel was not unique, as most had received a grade advancement upon coming to the project. He predicted that significant turnover would begin in the very near future, as civilian personnel were looking for more senior positions in projects that were growing and upon which they could have a significant impact. Most of the personnel were the type, in his judgement, who were most satisfied in a developing design situation instead of a production environment.

Seldom discussed is the turnover of personnel at the interfaces of the project. During the same period of time there have been four different Patrol Frigate Program Coordinators (NOP 371), four NAVSEC Design Coordinators, two Deputy Chiefs of Naval Operations (Surface Warfare) (NOP 03), two Chiefs of Naval Operations, four Deputy Commanders of the Naval Sea Systems Command for Surface Ships, three Chiefs of Naval Material, four Vice Chiefs of Naval Material, four Naval Sea System Command Comptrollers, three Naval Sea Systems Command Deputy Commanders for Contracts, three Deputy Chiefs of Naval Material for Procurement and Production (NMAT 02) and finally two Assistant Secretaries of Navy (Installation and Logistics) (ASN(I&L)). In the opinion of senior project personnel, the changes in NOP 03, NMAT 02 and ASN(I&L) were more significant to the project than the changes within the project staff itself. As a minimum, these new officials had to be made knowledgable about the program, requiring effort and time to be expended by the

perject personnel. Changes in management philosophy and need perception on the part of new officials required modification of both the management of the project and the technical requirements of the ship itself.

2. Ships Service Diesel Generators

As originally envisioned, the Patrol Frigate was to have four 750 KW ships service diesel generators. Loads of 1200 KW and 1350 KW were being estimated for the cruising and battle conditions respectively. NAVSEC used the traditional load growth factor of 1.3 in all categories except propulsion and steering, where 1.0 was used, to compute a cruising load allowance of 1518 KW and a battle load allowance of 1713 KW. The estimated load continued to grow as loads were better defined until August 1971 when the cruising load was estimated at 1569 KW and the battle load at 1746 KW. The decision was made to attempt to reduce the loads to bring the power requirements within the capability of two generators with one generator serving as a standby. The use of three generators instead of four would provide a weight savings of 32,400 pounds in the diesel generator alone, plus the weight saved in supporting systems. The cost savings for the generator alone would be $160,000 per ship. By late September 1971, the cruising and battle loads had been reduced to 1393 KW and 1408 KW respectively. Though this load was within the two generator limit, routine load growth factors would bring the loads to 1774 KW and 1885 KW -- well above the two generator limit.

Against the objections of the NAVSEC electrical division designers, it was decided to change the growth factors, allowing 1.3 growth only for Interior Communications, Ship Electronics, Ordnance Systems and Power Conversion Equipment. This brought the load allowances to within 100 KW of the two generator limit and further conservation brought the load allowance to below the 1500 KW limit by November 1971.

Between November 1971 and March 1972, it was decided to increase the generator capacities to 1000 KW by turbocharging the diesel and to go to an "all electric" ship concept, deleting the auxiliary boiler with its space, weight and cost. The electrical designers were uneasy about the use of turbocharged diesels as they have decreased response and less overload capability for the time required to bring up a standby generator. Designers also returned to the use of a 1.3 margin in all but propulsion. By May 1972, it became evident that a steam capability would have to be restored if the load allowances were to fall within the two generator limit. With the auxiliary boiler restored, the loads were 1334 KW (Cruise) and 1437 KW (Battle) with load allowances of 1704 KW and 1834 KW, using the 1.3 margin.

In September 1972 it was decided to install a system for utilizing the waste heat from the propulsion turbines instead of the auxiliary boiler, which raised the cruising load over 400 KW and the battle load over 100 KW. This resulted in a cruising load allowance with full 1.3 margin in all

except propulsion of 2106 KW limit -- over the capability of two generators. Again to the dismay of the NAVSEC electrical designers, the tightened growth limits were re-imposed and the cruising load allowance was again within limits. Addition of electric space heaters and further definition of equipment loads brought the cruising load allowance back up to 2035 KW in February 1973, two months after the Preliminary Allocated Baseline was completed. The actual cruising load was 1920 KW at this time.

The Lead Ship Allocated Baseline was completed in April 1973 and the design effort was completed at NAVSEC. The design team was dissolved with the remaining functions taken over by the individual functional branches of NAVSEC. In the author's view, this shift of structure was accompanied by a decrease in innovation and a loss of "corporate memory." Interviews conducted by the author in February 1975 indicated that the electrical designers associated with the Patrol Frigate were firm belivers that a more traditional approach to the electrical system should have been used throughout and none of the rationale for earlier decisions could be found.

By December 1973, the cruising load had reached 2043 KW and the load allowance, even using the reduced load growth factors, had reached 2154 KW. Addition of fin stabilizers, special systems and changes in load factors (percentage of time in use) of ordnance systems brought the cruising load to 2245 KW in February 1974 and the Project Manager was force to make the decision to add another diesel generator.

The cost of the additional generator was $3,954,550 for the lead ship and estimated at $1,310,000 for each follow ship.

Another aspect of the generating system aboard the Patrol Frigate is the automatic startup, paralleling and load assumption of the standby generator. Because of the reduced manning, the system is designed such that loss of one generator will cause the electrical system to shed loads to remain within the capacity of the operating generators and the "stand-by" generator will be automatically started, paralleled with the running generators and assume its share of the load. The only ship in the U.S. Navy inventory with this type of system is the DD963 Class destroyer, which does not have turbocharged diesel generators. Discussions with NAVSEC and Project Office personnel indicated that there was no development program to produce and test this system in terms of actual hardware prior to installation on the ship. Testing of a single turbocharged diesel generator under various loads and automatic startup is intended, but transient characteristics will not be tested until the system is actually installed on the lead ship. NAVSEC electrical designer were very uncomfortable with the system and felt that it would only be satisfactory when it "had a MILSPEC." They seemed to the author to be incapable of handling significant departures from previously used routines. Although they seemed to recognize the inherent risk, they adopted a "wait and see" attitude. The impression received by the author was that if the system didn't work, they would be in a position

of having been correct in their assessment. If the system did work, they would routinize it by writing a Military Specification.

3. Major Changes

Throughout the conceptual, preliminary design and contract design phases of the Patrol Frigate acquisition, there were numerous significant tradeoffs in characteristics to achieve the desired combination of operational characteristics and cost for the Patrol Frigate. In the author's view, these tradeoffs represent the natural dialogue between OPNAV, the user, and NAVSEA, the producer. A unique aspect to this ship design, as described above, was the early establishment of displacement, cost and manning envelope. Some alternatives were put forward so late in the design sequence, however, that they impacted the orderly production of a contract design. As an example, the desire to change from one LAMPS helocopter to two delayed the start of contract design pending a study of the impact of the change. In October 1973 the Lead Ship Contract for Detail Design and Construction was awarded to Bath Iron Works based on the Lead Ship Allocated Baseline completion in April 1973.

Subsequent to contract award, there have been 99 major changes (Headquarters Modification Requests (HMR)) in addition to the diesel generator change described above. Table V indicates organizational responsibility for the changes and the effect of the cost of the lead ship and each follow ship. It should be noted in the case of NAVSEC

TABLE V

Major Priced Changes to the Patrol Frigate exclusive of diesel generator addition October 1973 - February 1975

Responsible Organization	Number of Changes	Cost Changes (thousand$) Lead Ship	Each Follow Ship
Project Office	16	- 793.54	- 60.54
Bath Iron Works and Other Vendors	19	+ 455.38	- 37.04
OPNAV	10	+1083.46	+280.81
NAVSEC	31	+ 904.21	+198.13
NAVELEX	11	+ 67.55	- 1.73
NAVSEA 04 (Gas Turbine)	2	+ 41.34	+ 20.70
NAVSEA 06 (Ordance)	5	+ 40.04	+ 8.82
NAVSEA 06 (Sonar)	2	+ 17.82	0
NAVSEA 98 (Reliability)	2	+ 216.45	+ 10.27
NAVAIR	1	+ 7.80	+ 3.14

responsible changes that insufficient records existed to trace the changes further than NAVSEC. The author recognizes the strong possibility that a number of changes may actually have been initiated outside the NAVSEC with NAVSEC acting only as the agent starting the change. If, for instance, a vendor discontinued the manufacture of a particular piece of equipment after its inclusion in the NAVSEC design, the change would be attributed to NAVSEC for specifying an item of equipment that did not exist. Historical records do not exist to show that the equipment was in production at the time it was specified but later discontinued.

A review of these changes indicates that 37% were initiated to correct deficiencies, 30% to accomplish improvements in the existing design, 15% from changes in operational requirements (including Reliability and Maintainability), and 18% to accomplish program cost reductions. Most of the cost reductions came from the Project office and the contractors, with OPNAV, NAVSEC and NAVELEX making minor contributions to cost reduction. Most of the changes resulting from changes in operational requirements came from OPNAV, with the rest coming from staff organizations such as NAVSEA 98 (Reliability & Maintainability). In relation to this type of change, Deputy Secretary of Defense William P. Clement, Jr. stated in his endorsement of Guided Missile Frigate (FFG) Decision Coordinating Paper No. 97;

> "I view the unexpected cost growth in GFE for this program with concern. The Navy should extend the authority of the FFG program manager so that the GFE program managers are responsible to the program manager for cost as well as configuration and performance."(29)

The evaluation of the desirability and cost effectiveness of these changes is beyond the scope of information available to the author but the ability of organizations clearly beyond the control of the Project Manager to make costly changes to the project is obvious. The Defense System Acquisition Review Committee decision relating to the LAMPS III helicopter, for instance, caused changes in the Patrol Frigate Program that have cost $283,700 for the lead ship and $80,000 per follow ship in modifications to the Patrol Frigate. Discussions with LAMPS personnel indicated that this cost was not being included in the cost of the LAMPS III program.

Unless great care is exercised by senior officers in OPNAV, the real effect of decisions external to the Project Office will never be recognized, it will in any case be reasonably well hidden as a footnote in reports to OSD and Congress.

4. DSARC III Briefings

According to Department of Defense instructions, the members of the Defense System Acquisition Review Council (DSARC) are the Director of Defense Research and Engineering and the Assistant Secretaries of Defense for Installation and Logistics, Comptroller and Program Analysis and Evaluation. The Assistant Secretaries for Intelligence and Telecommunications are members for programs within their area of responsibility and other key officials serve as advisors to the DSARC principals.

In preparation for a November DSARC III, the Patrol Frigate Project Manager had to provide 23 briefings starting in March of that year. Six briefings were given to NOP 37, four to NOP 03, one to NOP 01C, one to NOP 43, One to NOP 090, and two to the Vice Chief of Naval Operations. The Under Secretary of Navy received a briefing relating to the sonar. In the Office of the Secretary of Defense the staffs of DDR&E and ASD(I&L) received two briefings, the Cost Analysis Improvement Group two, the Director of Defense Test and Evaluation two, General Starbird one and the Assistant Secretary of Defense for Installation and Logistics one briefing. All of these briefings were in addition to scores of private meetings with officials in the Naval Material Command and the Naval Sea Systems Command.

Although the official instructions indicate a reasonably simple process by which a production decision (DSARC III) is obtained, this example provides an insight into the lengths to which a Project Manager must go to obtain a decision to let the contract and start production on follow ships. This of course does not include the requirements to obtain legislative authorization and appropriation for the ships, which constitute an additional burden on the project manager.

This form of management provides a significant drain, in the view of the author, of the resources of the project manager. These resources would seem to be better used in actually directing the project, leaving the coordinating function to other staffs.

B. INTERFACE PROBLEMS

Two major interfaces were explored by the author in interviews with people related to the weapons system acquisition process, but not directly related to the Patrol Frigate. The Congress/Department of Defense interface was explored with members of the House of Representatives Armed Service Committee and Appropriations Committee staffs and officers in the Office of the Chief of Naval Operations. The Material Command/Chief of Naval Operations interface was the subject of discussions with Project Managers in Naval Sea Systems Command and Naval Air Systems Command and officers in the Office of the Chief of Naval Operations.

The House of Representatives staff members generally characterized the information flow from the Department of Defense as good, but slow. They felt that the Department of Defense was generally better managed than other departments and that cost involved in Defense programs could be estimated with reasonable assurance. Other departments were involved in authorizations for which no reasonable estimate could be provided (such as unemployment benefits, where the number of unemployed is unpredictable). They were also interested in receiving more of the rationale behind Department of Defense Decisions, specifically the Program Decision Memoranda and Decision Coordinating Papers.

The staff officers in OPNAV, on the other hand, felt that Congress was trying to get into technical decisions that rightfully should be made by the Department of Defense. In

relation to the Material Command, the OPNAV officers felt that they were receiving information too late. They felt that engineering decisions were being made that affected the operational characteristics of the weapons system and they didn't find out about the decision until alternatives had been closed off.

The Project Managers generally felt that OPNAV was in essense making engineering decisions that were the perogative of the Project Manager. The extent of the arms length relationship between the Project Manager and his OPNAV contact varied significantly from project to project. In some cases the Project Manager characterized his OPNAV counterpart as a bothersome meddler and the OPNAV contact characterized the Project Manager as and independent who kept OPNAV "in the dark" unless there was a real problem. In other cases, both the Project Manager and the OPNAV contact felt they were a team, dependent upon each other and the adequacy of information flow between the two offices.

One other problem was frequently mentioned -- lack of "corporate memory." Legislative staff members had all been in their jobs long enough so that they felt no personnal problem this way, but they felt that there was a distinct problem in the Department of Defense with the loss of knowledge that they felt results from the constant turnover of personnel. They noted that Department of Defense personnel will periodically testify on a subject about which the congressional staff member has more background. This,

they felt, can be an embarressment both to the DOD staff member and to the Congressional Committee. The Project Managers who have been in the position for longer than two or three years felt that turnovers in senior Material Command, Office of the Chief of Naval Operations and Office of the Secretaries of Navy and Defense positions required a great deal of time to brief the newcomers and that constantly varying policies were disruptive to the orderly acquisition of a weapon system.

These examples illustrate the existance of significant problems at the interfaces between major organizations. The need to stabilize the key personnel is also emphasized.

VI. CONCLUSIONS AND RECOMMENDATIONS

A. CORRELATION OF STRUCTURE AND TASK

Based on review of existing literature and observation of organizations within the structure of the ships acquisition process, the author came to the conclusion that the structure was at variance with the task being performed. This will be illustrated with a specific example from the Patrol Frigate acquisition. The general character of the ships acquisition structure and tasks will then be examined. Finally, conclusions will be drawn relating to the correlation between the tasks common to developing and constructing any naval ship and the structure of the ship acquisition process today.

1. Patrol Frigate Diesel Generator Example

The organizations most significantly effecting the decisions relating to the diesel generator configuration on the Patrol Frigate were the Office of the Secretary of Defense, the Office of the Chief of Naval Operations, the Patrol Frigate Project Office, Naval Ship Engineering Center (NAVSEC) and the functional divisions of the System Commands responsible for providing the individual ship systems. The individual organizations within this structure, except for the Project Office and the NAVSEC Design Team, were permanent bureaucratic heirarchies. Both the Project Office and the Design Group started as fairly open organizations and moved

gradually to becoming more bureaucratic as they grew in size and age. NAVSEC and the Systems Commands, as bureaucracies, were sharply divided by function providing high complexity and minimal communication across system boundries. Organizational dependence was low, as the major occupation of the specific functional groups within the System Commands and NAVSEC was the solution of individual system problems in existing systems and the review of externally produced designs. The nature of the design review seldom required the groups to consider the effects of one system on the other systems or on the ship as a whole. This structure, in the view of the author, was well suited to the task of design review by system and solution of independent individual system problems.

The task, on the other hand, was the complete design of a ship under very stringent Office of the Secretary of Defense design to cost guidlines and restrictive Office of the Chief of Naval Operations design requirements. For the first time since the creation of NAVSEC in 1966, the Navy had to manage the integration of all of a major ship's systems, remaining within tight cost, displacement and manning constraints. In addition to the management risks inherent in attempting configuration management for the first time, under tight constraints, some technicological risks were introduced with the inclusion of new, untried equipment. The specific task under discussion was the management of power demands on the electric system and the provision of that power. The requirement for a design effort relating to

this task began with the earliest stages of design and will last until the detailed design is finalized. If constraints of displacement and cost are to be met, the feedback within the system must be strong enough to limit growth in individual system power requirements to the point where the limited generating system can meet the aggregate requirement.

In the author's view, the structure relating to the design of the Patrol Frigate was appropriate to the tasks associated with that process. This is based on the proven performance of the team in holding down growth of the ship, as expressed in terms of increasing displacement and cost, as compared with other recent Navy ships. In order to live within the design parameters, significant innovation in managing a set of tasks previously never done by the Navy was exercised by the group.

NAVSEC electrical designers, in discussions with the author, indicated that the Patrol Frigate would have been originally designed with four 750 KW diesel generators if the routine design practices had been followed. Instead of this, pressure from OSD and OPNAV to meet the cost and displacement goals resulted in the deletion of one generator. The small, innovative Design Group and Project Office were living within these limits, particularly when it was decided by the Project Office with the approval of OPNAV to accept the technicological risk of the turbocharged 1000 KW diesel generators. Lack of control within the structure by the Project Office of systems produced by the functional

organizations, particularly those of other system commands, and dissolution of the Design Team allowed the power requirements to grow. In this case, the change in structure resulting from dissolution of the design team was particularly significant. This ultimately caused the return to four generators. The core technology of the present groups responsible for the generators is based on reviewing proposals against existing technology (Military Specifications). Provided with the risk (technological uncertainty) of the turbocharged generators, these groups created a development plan that did not include integrated testing in spite of the fact that this is a potentially serious problem. In the author's view, this is the direct result of assigning a development task to a group that is used to considerably less innovative tasks and carries with it a high probability that preventable problems will occur. In other words, the high risk task was not in keeping with the organizational complexity of the structure.

2. Ship Acquisition Structure

The ship acquisition structure as a whole exhibits significant layering in decision making, a proliferation of staffs and rules and high degree of organizational complexity. Based on existing organization theory, this bureaucratic heirarcy is suited for routine, repetitive tasks, but not for tasks requiring major degrees of innovation. Further, routinization of innovative tasks has proved singuarly ineffective, based on the observation of modern writers. (15:p. 36)(73:p. 81)

3. Ship Acquisition Tasks

The tasks associated with developing and constructing a ship are very complex, but if the ship is to be acquired in an environment of little or no constraint it can be done by separate functional organizations with little coordination. In this case, task dependence is very low requiring low organizational dependence. If the ship is to be constrained design, however, the need for innovation decreases as the design progresses. This is based on the increasing detail required in the work and the decreased requirement for effort at subsystem interfaces.

4. Comparison of Ship Acquisition Structure and Task

The structure and the task are not, in the author's opinion, compatible. Innovation is required, particularly in the earlier stages of development, and the system is designed for the routine. High risk situations require an open structure with freedom to operate, not a highly constraining bureaucracy. Project Managers with whom this thesis was discussed were in general agreement that their success was in spite of the system instead of because of it.

In the author's opinion, a significant protion of the problems of ships acquisition result directly from this mismatch between the ships acquisition structure and the tasks it is required to perform. Until the basic structure is modified, successes in ships acquisition will come only from avoiding the system, not using it. Cosmetic changes to the structure will result only in changing the names of the

problems, as "claims" became "requests for equitable adjustment," not in improving the performance of the system as a whole.

B. RECOMMENDATIONS

1. Staff Units and Overhead

The existing organizations must be examined to verify correlation between the existing buffering, coordination and communication units and current needs for these units. Each unit must be observed in the light of its contribution to the outputs of the system. A management control system that would allocate staff expenses to specific projects is a possibility, as this would allow evaluation in dollar terms of the usefulness of a given staff to the project it theoretically support. Overhead allocation does have inherent problems. The bargaining function of overhead allocation may smear the true cost to a specific project. Transients in allocation may also provide an improper view of the overhead costs.

A second alternative, particularly for the services provided by the functional organizations to the staff organizations, is to allocate the budget to the Project Office. The Project Office would then "buy" the services of the functional organizations and staffs. Industrial funding, where used, is a form of this type of management control. Care would have to be given to the tasks performed by the functional and staff organizations that are not related to any specific project but are of overall use to the organization,

such as administrative support to top management, are not neglected. These would have to be recognized and funded directly to the staff or functional organization. This method would carry with it the inherent disadvantage that the staff organization would have to develop a "sales" function to convince the project organizations of the usefulness of their services. The principle advantage is that the project organization, which is generally evaluated in terms of its output, would base its "purchase" of services on their value to the output. This would result in evaluation, indirectly, of the staff and functional organization outputs in terms of the output of the project office -- the ship.

2. Management Continuity

The quick answer to the problem of continuity of management is to keep the same management team on for the duration of the development and production of the ship. The obvious drawbacks are that it may not constitute the best use of personnel and it is at variance with the manpower philosophy of the Navy. Different types of people are more effective in different settings of risk, and within different structures.(59:p. 318) One type of person does best in the unstructured environment of basic research and concept formulation, another in the risk prone stages of development and still a third type of person in the routine of production and operation. With this approach, turnovers would take place at the beginning of the validation phase and at the end of the full scale development pahse as shown on Figure 10.

For a ship this would mean the core project management team would start while the characteristics of the ship are being determined and remain with the project until completion of sea trial testing of the lead ship. With an orderly turnover, a second team would supervise the further construction of follow ships. The earliest states of development of individual systems would be under the management of a team that would be brought into the project as the system was incorporated into the ship. The management of the system would then be gradually turned over to the office responsible for the coordination of the set of systems in which the specific system was contained. This structural change over the duration of the project would provide conduct more suitable to each stage of the development and construction.

Pre-education of project personnel would foreshorten the time required to adequately turn over the management of a phase of the development and construction and would be particularly helpful when turnover is required at other than key points. Expansion and contraction of applicable subunits is obviously desirable as their contribution to the development changes, but discontinuation of a function, as the NAVSEC Design Team was dissolved, is detrimental to the continuity of the project. Finally, it should be noted that the control of personnel turnover should also apply to the people occupying interface positions in other organizations. Specifically, the officers in OPNAV, NAVMAT, NAVAIR, etc. that are assigned to the specific position of interfacing with a particular

project should also rotate reasonably close to the time of major transitions.

3. Task Division

Another way to approach the apparent mismatch between the structure and the tasks is to divide the tasks based on the different types of management that are required. Under this approach, system and subsystems would be developed using existing platforms. These would be based on basic needs such as "improved communications," "energy transfer" and "new propulsion methods." The emphasis would be on new directions instead of further refining existing technology. When the basic concepts had been proved, the system would be placed "on the shelf" awaiting the need for a ship. Ships then would be developed and constructed based on existing technology and a need that was related to the force requirements. The major obsacle to this program would be the acceptance by the existing structure of the cost of systems that either prove not worthwhile and are canceled in development or that are developed and find no use in a ship because of lack of force requirements.

The major advantage of this approach is that it foreshortens the time required to develop a ship and reduces the risk inherent to developing a system at the same time it is being integrated into a ship. Another advantage is that it allows a relatively level research and development effort, independent of the fluctuating needs for ships.

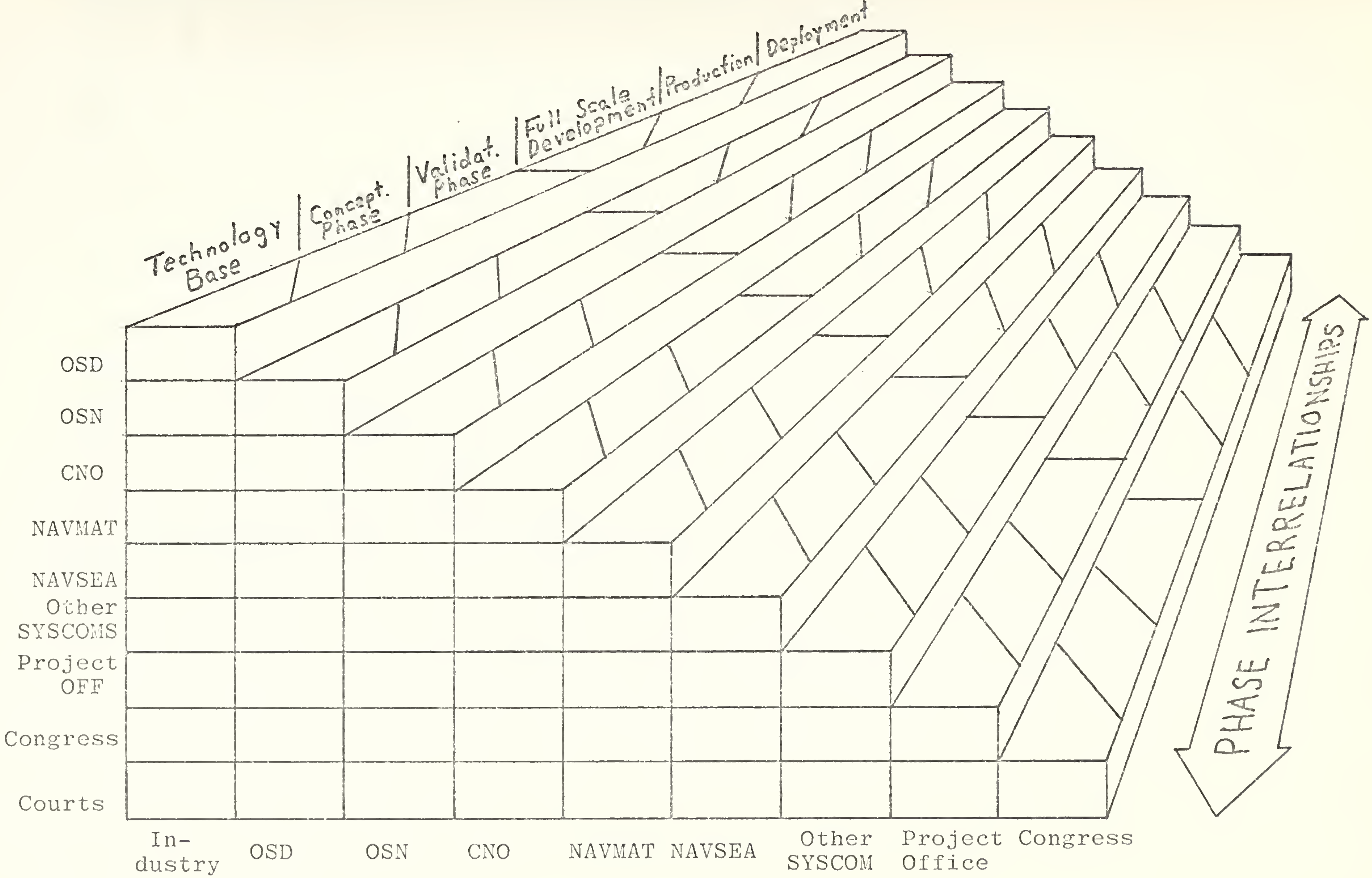
4. Further Research

Perhaps the most significant requirement is for further, integrated research into the weapons system acquisition process. The work started by the Commission on Government Procurement needs to be extended to include not only the effects of the different phases of weapons development on each other, but of the different organizations and facets of the structure on the process as a whole.

Using a systems approach, the author would recommend that each organization be considered a transformation device that converts inputs to outputs and is subject to command inputs and feedback. The mechanics of how and why each organization in the weapon system acquisition structure translates inputs to outputs and how it responds to signals would then be explored. Next an incidence mattrix, such as the one shown in Figure 17 would be constructed and the interactions between each pair of organizations and between the organizations and the environment would be considered. The inputs and outputs would be the same as those used for the individual organization studies. Should additional inputs or outputs be recognized, they would be fed back into the individual organization model, which would have to be a adjusted accordingly. For the model containing successive pairs of organizations the organizations other than the two being observed would be considered part of the environment.

The study would then proceed on to models containing these organizations, then four organizations and so forth as

Figure 17 - Ship Acquisition Interaction Incidence Mattrix.


Technology Base
Concept. Phase
Validat. Phase
Full Scale Development
Production
Deployment
PHASE INTERRELATIONSHIPS
OSD
OSN
CNO
NAVMAT
NAVSEA
Other SYSCOMS
Project OFF
Congress
Courts
In-dustry
OSD
OSN
CNO
NAVMAT
NAVSEA
Other SYSCOM
Project Office
Congress

as shown in Figure 18. With the study of each model, the interactions and mechanics of operation would be considered over the whole range ("time dimension") of the weapons system acquisition process from the creation of the technology base through the production and deployment of the system. It is this author's contention that only by studying the actual structural interrelationships of the entire weapons system acquisition process over the full course of development of the system can meaningful changes be made to change the conduct of the structure to improve the performance of the process.

In interpreting the results of such a study, great care must be used. As with the Heisenberg Uncertainty Principle in physical measurements, which states the more exact the measurement the more the act of measuring disturbs the object being measured, studies whose purpose is to change the structure will be subject to biased responses from those with a vested interest in keeping the structure intact or from those who would profit from making specific changes in the structure. To a student with no authority to change the structure, authorities in legislative staffs, material command staffs, the office of the Chief of Naval Operations and the Office of the Secretary of Defense were extremely frank. There is good reason to believe responses to the same questions would have been more carefully couched had the author had the authority to make changes in the system.

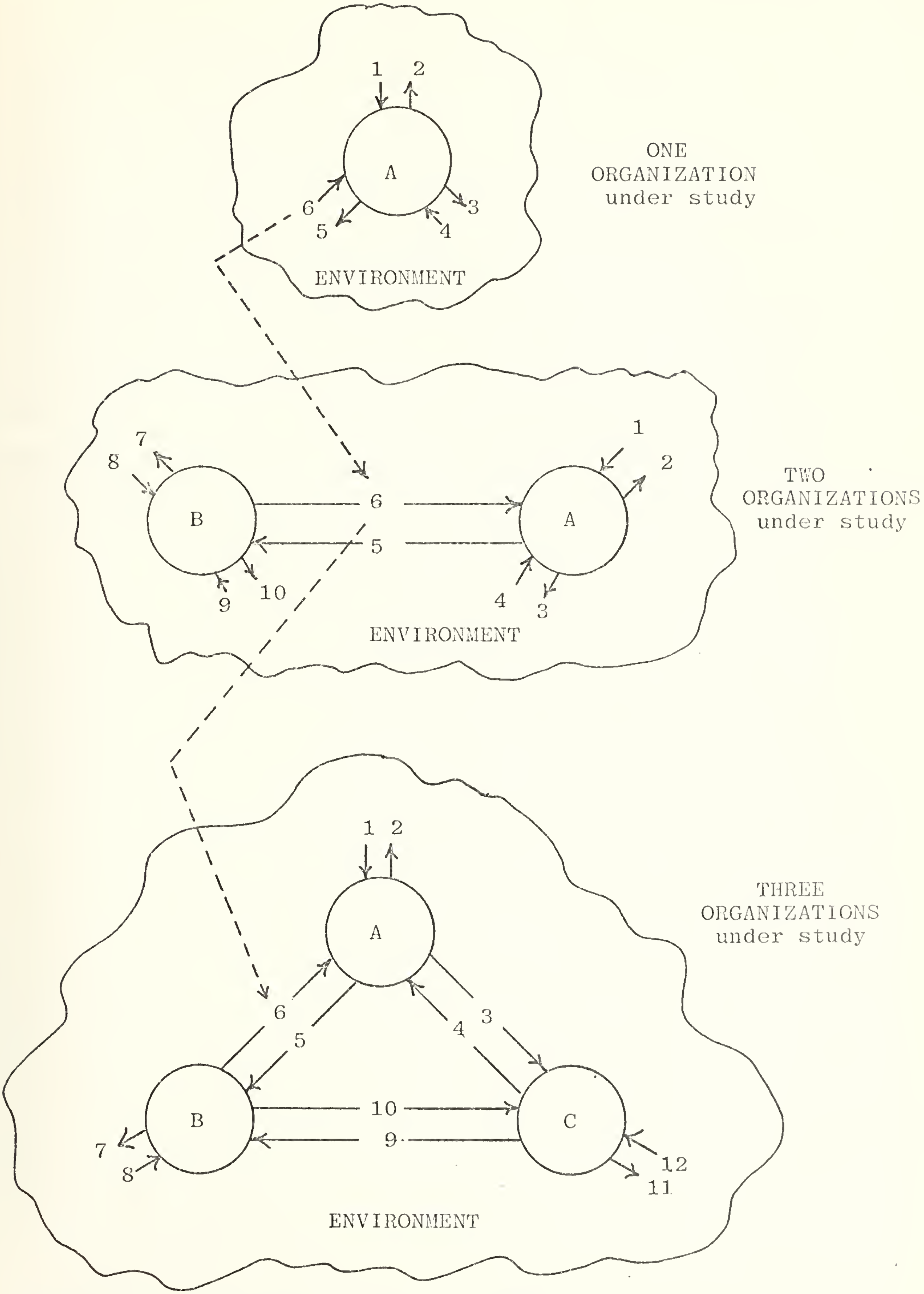

1
2
A
3
4
5
6
ONE ORGANIZATION under study
ENVIRONMENT
7
8
B
6
5
9
10
1
2
A
4
3
TWO ORGANIZATIONS under study
ENVIRONMENT
1 2
A
6
5
4
3
THREE ORGANIZATIONS under study
B
C
10
9
7
8
12
11
ENVIRONMENT

Figure 18 - Inputs and Outputs to Organization

The other problem inherent to such a study, in the author's view, is the effect of changes in themselves. The numerous changes that have happened in the weapons system acquisition structure have, in themselves, created transient conditions which make observation difficult. In studying the process, it is rarely, if ever, possible to observe a weapons acquisitions project of any magnitude that has gone through the entire development and production process under one structure. The effects of the variation of structure must be allowed for to the maximum extent possible, but this should not preclude the investigation.

APPENDIX A

RECOMMENDATIONS ON ACQUISITION OF MAJOR SYSTEMS - BY COMMISSION ON GOVERNMENT PROCUREMENT DECEMBER 1972

1. Start new system acquisition programs with agency head statements of needs and goals that have been reconciled with overall agency capabilities and resources.

    (a) State program needs and goals independent of any system product. Use long-term projections of mission capabilities and deficiencies prepared and coordinated by agency component(s) to set program goals that specify:

        (1) Total mission costs within which new systems should be bought and used.
        (2) The level of mission capability to be achieved above that of projected inventories and existing systems.
        (3) The time period in which the new capability is to be achieved.

    (b) Assign responsibility for responding to statements of needs and goals to agency components in such a way that either:

        (1) A single agency component is responsible for developing system alternatives when the mission need is clearly the responsibility of one component; or
        (2) Competition between agency components is formally recognized with each offering alternative system solutions when the mission responsibilities overlap.

2. Begin congressional budget proceedings with an annual review by the appropriate committees of agency missions, capabilities, deficiencies, and the needs and goals for new acquisition programs as a basis for reviewing agency budgets.

3. Support the general fields of knowledge that are related to an agency's assigned responsibilities by funding private sector sources and Government in-house technical centers to do:

(a) Basic and applied research
(b) Proof of concept work
(c) Exploratory subsystem development

Restrict subsystem development to less than fully designed hardware until identified as part of a system candidate to meet a specific operational need.

4. Create alternative system candidates by:

(a) Soliciting industry proposals for new systems with a statement of the need (mission deficiency); time, cost, and capability goals; and operating constraints of the responsible agency and component(s), with each contractor free to propose system technical approach, subsystems, and main design features.

(b) Soliciting system proposals from smaller firms that do not own production facilities if they have:

(1) Personnel experienced in major development and production activities
(2) Contingent plans for later use of required equipment and facilities

(c) Sponsoring, for agency funding, the most promising system candidates selected by agency component heads from a review of those proposed, using a team of experts from inside and outside the agency component development organization.

5. Finance the exploration of alternative systems by:

(a) Proposing agency development budgets according to mission need to support the exploration of alternative system candidates

(b) Authorizing and appropriating funds by agency mission area in accordance with review of agency mission needs and goals for new acquisition programs

(c) Allocating agency development funds to components by mission need to support the most promising system candidates. Monitor components' exploration of alternatives at the agency head level through annual budget and approval reviews using updated mission needs and goals.

6. Maintain competition between contractors exploring alternative systems by:

(a) Limiting commitments to each contractor to annual fixed-level awards, subject to annual review of their technical progress by the sponsoring agency component

(b) Assigning agency representatives with relevant operational experience to advise competing contractors as necessary in developing performance and other requirements for each candidate system as tests and tradeoffs are made

(c) Concentrating activities of agency development organizations, Government laboratories, and technical management staffs during the private sector competition on monitoring and evaluating contractor development efforts, and participating in those tests critical to determining whether the system candidate should be continued.

7. Limit premature system commitments and retain the benefit of system-level competition with an agency head decision to conduct competitive demonstration of candidate systems by:

   (a) Choosing contractors for system demonstration depending on their relative technical progress, remaining uncertainties, and economic constraints. The overriding objectives should be to have competition at least through the initial critical development stages and to permit use of firm commitments for final development and initial production.

   (b) Providing selected contractors with the operational test conditions, mission performance criteria, and lifetime ownership cost factors that will be used in the final system evaluation and selection.

   (c) Proceeding with final development and initial production and with commitments to a firm date for operational use after the agency need and goals are reaffirmed and competitive demonstration results prove that the chosen technical approach is sound and definition of a system procurement program is practical.

   (d) Strengthening each agency's cost estimating capability for:

      (1) Developing lifetime ownership costs for use in choosing preferred major systems
      (2) Developing total cost projections for the number and kind of systems to be bought for operational use
      (3) Preparing budget requests for final development and procurement.

8. Obtain agency head approval if an agency component determines that it should concentrate development resources on a single system without funding exploration of competitive system candidates. Related actions should:

(a) Establish a strong centralized program office within an agency component to take direct technical and management control of the program.

(b) Integrate selected technical and management contributions from in-house groups and contractors.

(c) Select contractors with proven management, financial, and technical capabilities as related to the problems at hand. Use cost-reimbursement contracts for high technical risk portions of the program.

(d) Estimate program cost within a probable range until the system reaches the final development phase.

9. Withhold agency head approval and congressional commitments for full production and use of new systems until the need has been reconfirmed and the system performance has been tested and evaluated in an environment that closely approximates the expected operational conditions.

(a) Establish in each agency component an operational test and evaluation activity separate from the developer and user organizations.

(b) Continue efforts to strengthen test and evaluation capabilities in the military services with emphasis on:

(1) Tactically oriented test designers
(2) Test personnel with operational and scientific background
(3) Tactical and environmental realism
(4) Setting critical test objectives, evaluation, and reporting.

(c) Establish an agencywide definition of the scope of operational test and evaluation to include:

(1) Assessment of critical performance characteristics of an emerging system to determine usefulness of ultimate users
(2) Joint testing of systems whose mission cross service lines
(3) Two-sided adversary-type testing when needed to provide operational realism
(4) Operational test and evaluation during the system life cycle as changes occur in need assessment, mission goals, and as a result of technical modifications to the system.

10. Use contracting as an important tool of system acquisition, not as a substitute for management of acquisition programs. In so doing:

(a) Set policy guidelines within which experienced personnel may exercise judgment in selectively applying detailed contracting regulations

(b) Develop simplified contractual arrangements and clauses for use in awarding final development and production contracts for demonstrated systems tested under competitive conditions.

(c) Allow contracting officials to use priced production options if critical test milestones have reduced risk to the point that the remaining development work is relatively straight-forward.

11. Unify policymaking and monitoring responsibilities for major system acquisitions within each agency and agency component. Responsibilities and authority of unified offices should be to:

    (a) Set system acquisition policy

    (b) Monitor results of acquisition policy

    (c) Integrate technical and business management policy for major systems

    (d) Act for the secretary in agency head decision points for each system acquisition program

    (e) Establish a policy for assigning program managers when acquisition programs are initiated

    (f) Insure that key personnel have long-term experience in a variety of Government/industry system acquisition activities and institute a career program to enlarge on that experience

    (g) Minimize management layering, staff reviews, coordinating points, unnecessary procedures, reporting, and paperwork on both the agency and industry side of major system acquisitions.

12. Delegate authority for all technical and program decisions to the operating agency components except for the key agency head decision of:

    (a) Defining and updating the mission need and the goals that an acquisition effort is to achieve

    (b) Approving alternative systems to be committed to system fabrication and demonstration

(c) Approving the preferred system chosen for final development and limited production

(d) Approving full production release.

APPENDIX B

Directives Applicable to the Acquisition of a Naval Ship

DOD Directive 5000.1, *Acquisition of Major Defense Systems.*

DOD INST 7000.2, *Performance Measurement for Selected Acquisitions.* *

DOD INST 7045.7, *The Planning, Programming and Budgeting System.*

DOD INST 7045.8, *Procedures for Updating Program Data in the Five Year Defense Program (FYDP).*

SECNAVINST 5000.1, *System Acquisition in the Department of the Navy.*

SECNAVINST 5420.172, *Establishment of the Department of Navy System Acquisition Review Council (DNSARC).*

SECNAVINST 7700.5, *Selected Acquisition Report (SAR).*

OPNAVINST 1500.8G, *Coordination of Personnel Requirements and Training Programs with Material Developments (Other than Air, Medical and Reserve).*

OPNAVINST 3500.23A, *Assembly, Organization and Training of Crews for U.S. Navy Ships Commissioned in Time of Peace.*

OPNAVINST 3910.16B, *Research and Development Planning Summary (DD Form 1634) for Research and Development Program Planning Review.*

OPNAVINST 3960.10, *Test and Evaluation.*

OPNAVINST 4441.12, *Supply Support of the Operating Forces.*

OPNAVINST 5000.41B, *Pre-Defense System Acquisition Review Council (DSARC) Procedures.*

OPNAVINST 5000.42, *Weapon System Selection and Planning.*

OPNAVINST 5100.8A, *Safety Program, Implementation.*

OPNAVINST 5101.1B, *Resolution of Radio Frequency Hazard Problems.*

OPNAVINST 5330.8, *Navy Standard Workweek for Enlisted Personnel*.

OPNAVINST 5420.2J, *Chief of Naval Operations Executive Board*.

OPNAVNOTE 5430, *Changes to the Organization of the Office of the Chief of Naval Operation* (creation of OP-97).

OPNAVINST 7720.2, *Classification of SCN Cost Estimates*.

OPNAVINST C9010.XXX, *Approved Characteristics*.

NAVY PROGRAMMING MANUAL

NAVMATINST 3910.10C, *Implementation Procedures for the Navy Advanced Concepts*.

NAVMATINST 4000.20A, *Integrated Logistic Support Planning Policy*.

NAVMATINST 4441.1A, *Supply Readiness Objectives and Milestones for Newly Constructed Ships*.

NAVMATINST 5430.49A, *Major Surface Combatant Ships Project Manager (PM-18)*.

NAVMATINST 7000.14B, *Improved Management Procedures within the Naval Material Command for Ship Construction and Conversion Projects under the SCN Appropriation*.

NAVSHIPSNOTE 4130 of 21 April 1970, *MIL-STD-480 Configuration Control-Engineering Changes; Naval Ship Acquisition*.

NAVSHIPSINST 4341.5C, *Government Furnished Material for New Construction and Conversion*.

NAVSHIPSINST 4441.92A, *Supply Readiness Objectives and Milestones; Implementing Procedures*.

NAVSHIPSINST 5430.XXX, *Ship Acquisition Project, designation of*.

NAVSHIPS 0900-031-0010, *NAVSHIPS Fitting Out Manual*.

NAVSHIPS 0900-032-6010/NAVPERS 93904, *General Specifications for Training Operations and Materials*.

Concept Exploration Report.

Functional Baseline Description.

NAVSEC Preliminary Allocated Baseline Plan.

NAVSHIPS Advance Procurement Plan No. XXX-XX-XX-X.

Program PABL and Lead Ship Contract Review Plan.

NAVORD Publication OP-3347, *Navy Safety Precautions*.

MIL-STD 470, *Maintainability Program Requirements for Systems and Equipments*.

MIL-STD-480, *Configuration Control-Engineering Changes, Deviations and Waivers.*

MIL-STD-785, *Requirements for Reliability Programs for Systems and Equipments.*

MIL-STD-881, *Work Breakdown Structure for Defense Materiel Items.*

MIL-STD-882, *System Safety Program for Systems and Associated Subsystems and Equipment Requirements for.*

MIL-STD-1375 (Navy), *General Requirements for Provisioning.*

MIL-P-15137C (Ships), *Provisioning Technical Documentation for Repair Parts, Special Tools and Test Equipment for Electrical and Mechanical Equipment*.

MIL-P-14014, *Preclusion of Hazards from Electomagnetic Radiation to Ordance, General Requirements for*.

MIL-Q-9858A, *Quality Program Requirements.*

*DOD INST 7041.3, *Economic Analysis and Program Evaluation for Resource Management*.

Reference: (64:pp.III-47-III-49, 38:pp.117-136, and 39:p.33)

APPENDIX C

Documents Relating to the Planning, Programming and Budgeting System

A. Department of Defense Planning Documents

1. Program/Budget Review Schedule - An annual Secretary of Defense memorandum issued to announce the schedule of significant events impacting on the DOD decision-making cycle.

2. Fiscal Guidance - Annual guidance issued by the Secretary of Defense which provides the fiscal constraints that must be observed by the JCS, the Military Departments, and Defense Agencies, in the formulation of force structures and Five Year Defense Programs, and by the Secretary of Defense staff in reviewing proposed programs.

3. Five Year Defense Program (FYDP) - The official program which summarizes the Secretary of Defense approved plans and programs for the Department of Defense. The FYDP is published at least once annually. The FYDP is also represented by a computer data base which is updated regularly to reflect decisions.

4. Joint Force Memorandum (JFM) - A document prepared annually by the JCS and submitted to the Secretary of Defense which provides recommendations on the joint force program within the fiscal guidance issued by the Secretary of Defense.

5. Joint Research and Development Objective Document (JRDOD) - A document prepared annually which provides the advice of the JCS to the Secretary of Defense concerning R&D objectives necessary to carry out the strategy and force recommendations in the JSOP.

6. Joint Strategic Objectives Plan (JSOP) - A document prepared annually which provides the advice of the Joint Chiefs of Staff to the President and the Secretary of Defense on the military strategy and force objectives for attaining the national security objective of the United States. In addition to recommendations on major forces, it includes the rationale supporting the forces and assessment of risks associated therewith, costs and manpower estimates, and other supporting data. The JSOP is published in three volumes: I - Strategy, II - Analysis and Force Tabulations, and III - Free World Forces.

7. Program Change Decision (PCD) - A Secretary of Defense decision, in prescribed format, authorizing changes to the Five Year Defense Program. (Also see Program/Budget Decision (PBD).)

8. Program Change Request (PCR) - Proposal in prescribed format for out-of-cycle changes to the approved data in the Five Year Defense Program.

9. Program Decision Memorandum (PDM) - A document which provides decisions of the Secretary of Defense on POMs and the JFM

10. Program Objective Memorandum (POM) - A memorandum in prescribed format submitted to the Secretary of Defense by the Secretary of a Military Department of the Director of a Defense Agency which recommends the total resource requirements within the parameters of the published Secretary of Defense fiscal guidance.

11. Program/Budget Decision (PBD) - A Secretary of Defense decision in prescribed format authorizing changes to a submitted budget estimate and the FYDP.

B. Navy Planning Documents

1. Navy Strategic Study (NSS)

The NSS provides concepts and philosophy concerning future naval contributions to national defense and to provide basic guidance for Navy long-range and mid-range planning. It appraises the world situation for these periods, outlines the potential threats and the national and military policy, objectives and strategy. It also summarizes the Navy's roles and tasks. The NSS is issued annually on 1 January, covering the period five to twenty years in the future from the end of the current fiscal year.

It is the primary basis for the Navy input to the JLRSS and JRDOD, provides a broad frame of reference for mid-range planning and provides long range strategic guidance.

2. Marine Corps Long-Range Plan (MLRP)

The MLRP sets forth a broad concept, supporting concepts and planning objectives and serves as a basis for the progressive and evolutionary development of Marine Corps forces. It provides guidance for Marine Corps long-range study and developmental actions as well as a common basis for continuing coordination with the other services in defining landing

force characteristics and requirements in the long-range period.

The MLRP addresses the period 10 to 20 years in the future. The primary source for development of the MLRP is the "Marine Corps Long-Range Study." That study utilizes other appropriate studies, including the JLRSS and the NSS, in appraising long-range strategic and technological forecasts. The MLRP addresses the transition between approved mid-range objectives and those desirable long-range capabilities which advancing technology provides, and future strategy may require. It treats qualitative goals rather than resource requirements and structuring of the Marine Corps. It is subject to review and revision every 5 years. There is an annual review of concepts of operation, and organizational and material objectives.

3. Department of the Navy Planning and Programming Guidance (DONPPG)

The Secretary of the Navy issues memoranda at appropriate times in the PPBS process to provide guidance for planning and programming actions. These memoranda amplify or supplement SECDEF guidance as necessary, establish Department of the Navy planning and programming policy, and identify areas requiring special attention by the CNO, CMC and Civilian Executive Assistants in the development of the Department of the Navy POM. Additionally, these memoranda are the means by which SECNAV decisions on CNO/CMC planning and programming proposals are transmitted. In the aggregate, these memoranda constitute the DONPPG.

4. CNO Policy and Planning Guidance (CPPG)

The CPPG transmits the essence of the SECDEF's and SECNAV's policy and planning guidance as it applies to the Navy, along with the CNO's amplification of this guidance. It presents the CNO's view of other factors such as changes in the international political scene, the military threat, domestic attitudes and national aspirations which affect the long-range direction of the Navy, and describes the ways in which he hopes to meet the SECDEF and the SECNAV guidance while moving toward the best mid-range posture attainable. The CPPG is reissued at the beginning of each program development cycle. The CPPG provides more specific guidance for the Navy input to the JFM and the input to the Navy POM. It presents the CNO's objectives for the future and lays out ground rules for the development of more detailed alternative ways of meeting these objectives.

5. CMC Program Policy and Planning Guidance (CMC PPPG)

The CMC PPPG transmits the essence of the DPPG and DONPPG as they pertain to the Marine Corps. It addresses the requirements of the national strategy on the Marine Corps relating to readiness, force levels and modernization.

6. Extended Planning Guidance (EPG)

The EPG extends the CPPG, based on the results of SECDEF's Extended Planning Annex (EPA), and provides guidance for refining CNO long-range planning with regard to projection of future development and operating costs. By extending the planning horizon ten years beyond the FYDP, the EPG provides a consistent Navy-wide frame of reference which, ultimately, will assist in: evaluating acquisition plans; guiding long-term R&D planning; and demonstrating affordability of current plans.

7. Marine Corps Mid-Range Objectives Plan (MMROP)

The MMROP develops concepts, objectives, and requirements necessary to accomplish statutory missions and projects them over a 10-year period beginning one fiscal year after the fiscal year of publication. The MMROP provides mid-range objectives guidance to Marine Corps commands, and information to the DOD, JCS, and Unified and Specified Commands. Additionally, the MMROP serves as a basis for Marine Corps inputs to the JSOP and other PPB actions, and for Marine Corps Research, Development and Studies efforts.

The MMROP contains an appraisal of the mid-range threat; a summary of the strategy developed in the JSOP, modified as necessary by subsequent national strategy guidance; a summary of Marine Corps role and missions; and statements of basic mid-range Marine Corps objectives. From these, a concept of operations, supporting active and reserve objective force structures, and operational objectives are developed. These, in turn, are used as a basis for developing training, installations, logistics and material, management systems and research and development objectives.

8. Navy Capabilities Plan (NCP)

The NCP provides a statement of capabilities in support of the JSCP and provides direction and guidance, as appropriate, for: mobilizing, organizing, training and equipping ready naval forces for prompt and sustained combat; the administration and support of naval forces assigned to Commanders of Unified and Specified Commands; Naval Forces

not assigned to Unified and Specified Commands and planning by Commanders of Unified and Specified Commands and their naval component commanders for the employment of assigned naval forces.

9. Marine Corps Capabilities Plan (MCP)

The MCP is the Marine Corps short-range plan that supports the JSCP. The MCP states the Marine Corps capability to accomplish its statutory mission and assigned tasks during the current fiscal year under all conditions of war. It provides planning information and guidance to Marine Corps subordinate commands for accomplishment of their assigned tasks.

The MCP displays force assignments made in the JSCP and structure and dispositions of Fleet Marine Forces. It provides plans for selective partial, full and/or total mobilization of additional resources to meet the Marine Corps general war posture. Mobilization plans include a concept of mobilizing selected Organized Marine Corps Reserve (OMCR) units and detachments to form task-organized units specifically tailored either for deployment or augmentation. Tasks and coordinating instructions for the various elements of the supporting establishments are provided. The MCP is updated at least annually.

10. Navy Support and Mobilization Plan (NS&MP)

The NS&MP contains policy and guidance for the logistics support of the phased expansion of the Department of the Navy in mobilization. The NS&MP supports the NCP and JSCP by stating logistic capabilities for the current and eight succeeding fiscal years under various conditions of war. Objectives are stated in terms of major resources and fields of endeavor, i.e., manpower, facilities, material and research and development needs. There are three separately bound supplements to the NS&MP; these are the Mobilization Manpower Allocation/Requirements Plan (M-MARP); the Civilian Mobilization Manpower Allocation/Requirements Plan (Civ-M-MARP) and the Mobilization Construction Plan (MOBCON).

11. Department of the Navy Five Year Program (DNFYP)

The Navy's portion of the DOD FYDP is summarized, displayed and distributed by the DNFYP. The DNFYP is structured in terms of major missions and support categories. It is published and distributed by the Program Information Center (DONPIC). It is updated on a continuing basis and within the Navy, represents the "approved" program.

12. CNO Program Analysis Memorandum (CPAM)

CPAMs are developed to present the CEB with an overview of the approved DNFYP and possible alternatives thereto. The individual CPAMs are: Strategic Forces, General Purpose Forces, Command, Control and Communications, Support and Logistics, Manpower and Training, and Summary CPAM.

Each CPAM describes the approved DNFYP and outlines the capabilities to carry out the overall goals and objectives. In addition, each CPAM identifies the major issues requiring a CEB decision plus the alternatives available/proposed for consideration in the current calendar year JFM/POM. Alternatives are considered in terms of fiscal levels prescribed in the CPPG. Subsequent to the CEB review and decision, the CPAMs form the basis for JFM and POM development.

13. Program Analysis Memorandum (PAM)

The General Purpose Forces area comprises the major portion of the total force structure. To provide an analytical method of examinging each subarea, four PAMs are prepared as follows: Sea Control/Projection Forces (Tactical Air); Sea Projection Forces (Amphibious); Support and Mobility Forces, and Sea Control Forces.

The individual PAM describes the approved DNFYP, reviews capabilities and identifies major issues. The alternative to obtain capabilities are discussed in light of fiscal constraints. Each PAM is presented to the CEB for tentative decisions to be incorporated in the CPAM for General Purpose Forces.

14. Resource Allocation Display (RAD)

To assist in the analysis of the approved and proposed DNFYP, a computerized model, the RAD has been developed for displaying the allocation of resources. In the RAD, numerous displays are possible. For example, resource allocations can be displayed by the following categories: Force areas; Major Mission and Support Categories; Function areas; PAMs; CPAMs, and Organization entity.

15. Force and Mission Sponsor Plan (FMSP)

Each Deputy Chief of Naval Operations (DCNO) and Director, Major Staff Office (DMSO) prepares and maintains an annually revised/updated FMSP which sets forth, as a minimum,

current FYDP approved force levels, FYDP procurements/ modification plans, reasonably achievable variations to the FYDP plans, and a fifteen-year extended projection of those plans. The baseline plan is constrained to the CPPG/EPG fiscal guidance. The FMSP sets forth, as concisely and coherently as feasible, the sponsor perceived force/mission needs necessary to carry out CPPG guidance and warfare, mission, or support plans which contain guidance for introduction of new or modernized systems along with user requirement objectives. The FMSP serves as the basis for annual CPAM issue paper inputs (and Sponsor Program Priorities (SPP)). The extended projection will be the basis for the Research and Development Plan (RDP).

APPENDIX D

Documents Relating to System Approval

The Decision Coordinating Paper (DCP)

a. The DCP is a summary document of not more than twenty standard pages that provides management with a broad overview of a major defense system program. The purpose of this document is to support the DSARC review and SecDef decision-making process throughout the program life cycle. It serves as the document for (1) program decisions by the SecDef, (2) recording the primary information on a program: the thresholds, the issues and risks, the alternatives, the reviews, rationale for the decisions, and affordability, and (3) recording SecDef decisions.

b. A SecDef decision is consummated when he signs the DCP, or issues a memorandum, authorizing the DOD Component to proceed with the program or directing another course of action. His decision set forth in the DCP establishes the limit of authority delegated to the cognizant DOD Component to conduct the program.

Research and Development Plan (RDP)

The Director, Research, Development, Test and Evaluation (DRDTE) prepares and maintains the RDP which serves as the central repository of research and development planning guidance. The RDP will be consistent with the CPPG, EPG, and PPGM and ensures a balanced effort responsive to mid- and long-range needs. The RDP is developed using the FMSP and other requirements, and serves as the primary guide to the research and development community for the establishment of projects which are responsive to operational needs. The RDP will be updated on a continual basis. The RDP will enunciate operational problems raised by FMSP that may require longer range activity in basic research and exploratory development. The RDP consists of two parts:

- Science and Technology Objectives (STO).
- The sum of approved Operational Requirements (OR).

Navy Advanced Concepts (NAC)

Advanced System Concept (ASC)

The NAC, an annual NAVMAT publication, consists of proposals of future concepts, each called an Advanced System Concept (ASC), arranged according to the fiscal year in which the system could be ready, form a technological standpoint, for initiation as an Advanced Development Project. The ASC's will in many cases be a direct response to the STO's. Information from all sources may be utilized to reflect proposals emphasizing Navy and Marine Corps operational needs. More than one ASC, each proposing a solution to an operational problem, may be included for publication in the NAC. The objective of the NAC is to provide candidate systems concepts, for Advanced Development within a 5-year period, for use in the POM process.

Each ASC will address a particular problem of, or offer an opportunity for a specific new capability for the Navy or Marine Corps operating forces. Selection of new projects for Advanced Development (6.3) consideration will be initiated by the DRDT&E by selecting particular items from these Candidate systems which are in consonance with the overall plans for increasing the operational capabilities of the Navy/Marine Corps. It is emphasized that items which are already in the DNFYP are not submitted for the NAC.

The Chief of Naval Development (CND) selects, assembles and publishes ASCs, submitted via a Systems Command, Bureau or office, for the NAC.

Each Systems Command, Bureau or Office may submit up to 30 ASCs, each limited to maximum of six pages, each year for consideration for publication in the NAC document. These are to reflect their perception of the most needed improvements in Naval or Marine Corps operating capabilities. These submissions are coded to one of the four RDT&E planning categories listed under the STO and in turn may be prioritized within each category.

Operational Requirement (OR)

ORs are concise statements of operational needs. The OR is the basic requirement document for all Navy acquisition programs requiring research and development effort. The OR solicits Development Plan (DP) from the Naval Material Command or Bureaus, as appropriate. The OR is limited to three (3) pages.

ORs are submitted for all development requirements. Draft ORs or brief statements of operational needs or requirements may be submitted by any fleet activity or Navy

command via the chain of command to the cognizant Force and Mission sponsors (F&M sponsors) with a copy to DRDT&E. When ORs or statements of operational need are submitted by activities located outside the local Washington area the originating activity is informed of the action contemplated by the cognizant F&M sponsor.

All ORs are concurred in by cognizant F&M sponsors and Director, Navy Program Planning, and promulgated by DRDT&E. ORs which clearly will lead to major weapon system acquisitions or will require costly R&D programs or early conceptual effort will be submitted to the CEB/ARC for concurrence prior to promulgation. Current approved ORs are maintained in the R&D plan until an NDCP, PM, or DCP has been issued. ORs are reviewed periodically for continued applicability, revision, or cancellation.

Development Proposal (DP)

The DP formally responds to the OR. DPs will be prepared and submitted by the Naval Material Command or Bureaus in accordance with the schedule contained in the promulgating letter forwarding the OR. If major modification of the OR is required, it will be so recommended. It is an iterative process through informal dialogue between the OPNAV OR sponsor and the CNM to prepare the DP. Through this avenue it is possible to resolve all questions in relation to the OR and the development of alternatives available to fulfill the requirement. If it is considered necessary to formally document modifications, a preliminary or partial DP is used to set forth the problem. A revised OR is the normal response.

Navy Development Concept Paper (NDCP)

The NDCP supports and promulgates CNO decisions to initiate conceptual development programs and establish appropriate Advanced/Engineering Development line items. The NDCP serves as the basis for preparing DCPs and PMs. NDCPs, DCPs, and PMs have the same basic format.

The NDCP defines program issues, the considerations which support the operational need, program objectives, program plans, performance parameters, areas of risk, and development alternatives. The NDCP approval procedure parallels that used for PMs and DCPs. Draft NDCPs will be presented for CNO approval at the CEB or ARC meeting. If required to further define the program or alternatives, additional (iterative) CEBs or ARCs will be used to develop the CNO decision (preferred alternative). For non-designated Navy development programs an abbreviated NDCP is prepared if required by CNO or the DNPP or DRDT&E for their approval.

For designated programs requiring further approval by high authority, the NDCP approval only authorizes extended systems planning and conceptual effort, within Navy authorized funding level as identified in the CNO approved program, and as ratified by the ASN(R&D), until program initiation approval is received. For SECDEF/DEPSECDEF or DSARC Principal-designated programs, the NDCP cover sheet must include the draft DCP or PM title. Approved NDCPs shall be promulgated by DRDT&E.

Project Master Plan (PMP)

The PMP provides uniform guidance for work planning and scheduling, and basic documentation which coordinates related Command effort for a specific project. The scope, depth and detail of the planning effort required for a major project varies with the product/capability to be produced, its complexity, magnitude, schedule and other factors. In consideration of these variations the Guidance for the Preparation of PMPs does not attempt to precisely prescribe the planning effort required for each individual project. Project Managers are encouraged to flexibly tailor the scope, depth and detail of their planning efforts to suit the particular needs of the Project. The Project Manager must determine for his particular project the optimum depth and detail of planning needed.

Science and Technology Objectives (STO)

The STO describes in broad terms the Navy's needs and problems requiring R&D solutions, and are based on the Navy's role, objectives, and threat anticipated in the 10- to 20-year future time frame. One STO is developed and maintained for each of the warfare/support areas shown under the following four RDT&E Planning Catagories:

I. Strategic Deterrence
    A. Sea-Based Strategic Warfare

II. Sea Control
    A. Anti-Air Warfare
    B. Anti-Submarine Warfare
    C. Anti-Ship Warfare
    D. Mine Warfare/Mine Countermeasures

III. Projection of Power Ashore
    A. Amphibious Warfare
    B. Tactical Warfare Ashore
    C. Special Warfare

IV. Mission Support
    A. Personnel/Medical
    B. Support, Logistics & Underway Replenishment
    C. Ocean Surveillance
    D. Command, Control and Communications.

APPENDIX E

GENERAL ACCOUNTING OFFICE (GAO) REPORTS APPLICABLE TO NAVY WEAPONS SYSTEM ACQUISITION

OSD Case #	
2826	Termination of Contract for Construction of Nuclear Attack Sub
2933	Weakness in Award and Pricing of Ship Overhaul Contracts
2976	Two Proposed Methods for Enhancing Competition in Weapons Procurement
3031	Questionable Waiver of Pre Award Audits of Non Competitive Price Proposals
3041	CPSR's
3050	Pricing of Bomb Bodies
3053	Turnover of Managers Directing R&D Projects
3062 and 3062A	Pricing of Changes Ships Construction
3063	Production Prior to Completing Development
3084	Same as 3063 - Covers "DASH" Project
3110	DOD Career Program Procurement Personnel
3112	Processing of ECP's
3119	Use of Performance and Delivery Incentives
3120	Same as 3063 Covers SQS-26
3161	Competition in Emergency Procurements
3190	Analysis of F 14/F 15 Contracts
3192	Application of Should Cost
3221	Pre Award Survey Improvements
3223	Defense Industry Profit Study

3244	A-7 Contract
3253A	Inhouse Lab IR&D Program
3260	Multi Year Procurement
3288	Contracting versus Inhouse Procurement
3293	Shipbuilding Claims
3298	RDT&E
3301	ADP Software Acquisition
3310 and 3310A	Contractual Features S3A Program
3336	Review of F-14 Costs
3338	Control of Ship Construction Costs Private Yards
3362	Truth in Negotiations
3366	Theory and Practice of Cost Estimating
3367	Feasibility of Constructing Weapon System Price Indexes
3389	Test and Evaluate Major Systems
3423	Contract Termination in DOD
3434	Lockheed Claims
3444	Impact of Inflation on Cost of Proposed Programs
3453	Cost and Procurement Practices Litton, Pasc
3465	UYK-7 Computer
3499	Procurement of Steal without Cost and Pricing Data
3543	Implementation of LCC Acquisition Technique
3597	Cost Growth in Major Weapon Systems
3009	Payments for IR&D and B&P Costs
3623	Operations and Activities of the Renegotiation Board
3627	Assessment of Navy Should Cost Studies

3628	Benefits and Drawbacks of U.S. Participation in Military Coop. R&D Programs
3637	Industrial Management Reviews of Defense Contractor Operations
3653	Executive Branch Response to Recommendations of Commission on Government Procurement
3674	Outlook for Production of LHA and DD963 Shipbuilding Programs
3734	Financial Status of Major Weapon Systems
3740	Effectiveness of Testing on SES Program
3764	Assessment of Should Cost Studies
3774	Assessment of Army & Navy Should Cost
3775	Dual Awards for Prototypes
3776	Military Service Planning for Innovative Research
3792	ARPA Approach to Management of Technology Transfer
3794	Use of ACP's and TCP's to plan Technology Base Activity
3796	Improvements needed for Negotiating Prices of Noncompetitive Contracts over $100,000
3845	Cost Growth or CVAN Construction Program
3849	Status of Selected Major Weapon Systems
3864	Life Cycle Costing - It's Status and Potential Use in Major Weapon Systems Acquisition
3870	Government Support of Shipbuilding Industrial Base.

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